

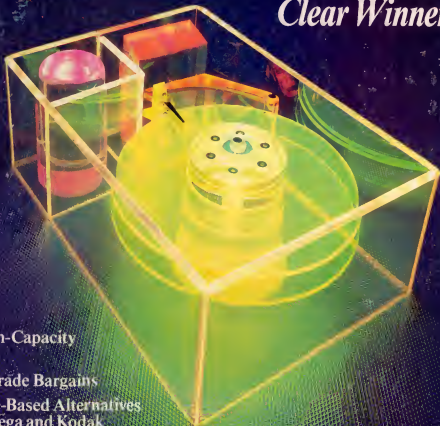
PC MAGAZINE

VOLUME 6 NUMBER 11
JUNE 9, 1987



FIRST LOOKS: IBM'S
PERSONAL SYSTEM/2
MODEL 60

Hard Disks: Tough Choices, Clear Winners



- Hot, High-Capacity Drives
- Best Upgrade Bargains
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Hard Disk
Secrets and Shortcuts

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“Borland has succeeded in stretching the language without weighing us down with unnecessary details... Turbo Basic is the answer to my wish for a simple yet blindingly fast recreational utility language. The one language you can't forget how to use, Turbo Basic is a computer language for the masses, the masters, the masses, and me.”

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John C. Dvorak 99

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Reflex: the critics' choice

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Jerry Pournelle, BYTE

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Peter Norton, PC Week

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Marc Adler, author of *New York Word*, took his Bachelors degree in Computer Science from State University of New York at Albany. He received his Masters degree, in Computer Science, from the University of Arizona. He pursued his Ph.D at the Kourant Institute of Mathematics at N.Y.U. before he determined it was hopeless. His word processing program is an easy to use, powerful, text editing and formatting tool. In fact, it contains many features such as:

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GOODBYE, IBM...



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PC MAGAZINE

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Executive editor Paul Somerson

Quick, what's the single most powerful addition you can make to your computer? Turbo board? Math coprocessor? Mouse? New software?

Wrong. The hands-down best productivity booster you can buy for your computer is a hard disk. It'll save time in all kinds of ways: no more waiting

for software to load from floppy disks, no more searching through 30 floppy disks to find the file you need, no more floppy disks, period. It's an enticing alternative for those of you who continue to muddle through without the speed and power of a hard disk.

As executive editor Paul Somerson says in "How to Handle Your Hard Disk," page 199, "Floppies are how new software products are packaged, and how you back up your files. They're also for the birds. A hard disk gives you instant access to all your files, speeds up operation dramatically, and makes 'disk full' errors a lot less common."

A few years ago, the high cost of hard disks was a decent excuse for going without. But prices have come down significantly, and there are many more products out there to choose from. So there's no longer any reason for not having a hard disk. Except maybe that you don't know what to look for, how much to spend, whether you need 8 or 80 megabytes, and whether to choose an internal or external disk. Options abound, but you shouldn't be intimidated by the number of choices you'll have to make.

This issue's cover story can help answer your questions. If you're a first-time disk buyer or someone looking for a replacement or larger disk, or if you just want to know how the disk you bought stands up against the competition, turn to our hard disk stories. We tested and reviewed inexpensive mail-order units, ready-to-install disk-and-controller kits from system integrators, and—for space hogs, network users, or just plain dreamers—100-megabyte-plus storage systems.

There's also something here for people who are sitting contentedly with their hard disks already in place. How many of you are really getting the most from your disk? All neatly organized, is it? No duplicate files? Backups all in place? Ready to face a crash with equanimity? You can lie—or you can read Paul Somerson's productivity article and get the inside story on hard disk organization and maintenance from someone who's crashed more hard disks than you've had hot dinners.

Somerson offers dozens of useful DOS tricks and tips, a recommended directory structure guaranteed to keep your files in order, and some of our best utilities that have been reprinted and updated from past issues of PC Magazine.



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- Journal & per feature for corrections
- Unlimited journals
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- Automatic budgeting
- Financial ratios and more

ACCOUNTS RECEIVABLE:

- Open invoice or balance forward
- Flexible aging
- On-line automatic posting
- Departmentalization by customer
- Customized text on statements
- Cash flow analysis
- Mailing labels
- Flexible invoice allocations
- Year history
- Automatic finance charges
- Notepad window
- Supports partial payments
- Sales analysis and sales budgeting and more

ACCOUNTS PAYABLE:

- Check printing from multiple bank accounts
- Automatic allocation of available cash
- Vendor directories and labels
- Flexible aging
- On-line posting to other modules
- Flexible invoice allocations
- Automatic reprinting of checks
- Notepad window
- Purchase forecasting
- Unlimited allocations per invoice
- On Invoices per check
- Browse invoice and more

BILLING:

- invoicing on plain or pre-printed forms
- Special service billing routine
- Utilities journals
- Invoice remarks
- On-line posting to other modules
- Credit memos
- Revenue & cost allocation
- Packing lists
- Point-of-sale invoicing and more

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- Physical inventory routing with count sheets
- Accepts any measure of units
- Special services file
- Automatic changing of costing methods
- Year history for all products and services with automatic forecasting
- Automatic pricing assignments
- Alert & activity reports
- On-line posting and more

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- 7/9 Items per P.O., per line and total discounts in 5 or 6
- Full back-order control
- Purchase journal
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- On-line processing and more

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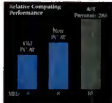
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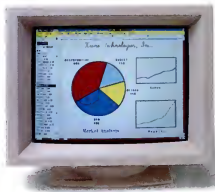
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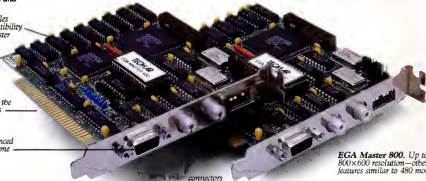
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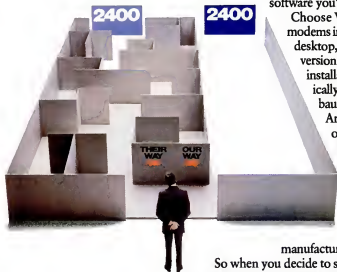
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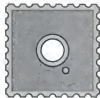
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LETTERS TO PC MAGAZINE



BUSINESS GRAPHICS

While we applaud your recognition of business graphics packages ("Graphics Software on Display," *PC Magazine*, Volume 6 Number 5), we were greatly disappointed by your omission of *The Smart Software System* and *The Smart Spreadsheet* with *Graphics*.

The Smart Spreadsheet, which can be used as a standalone package or as part of the modular integrated *Smart Software System*, offers an extremely versatile range of presentation graphics capabilities.

With *Smart*, up to 78 graphics options are available for each spreadsheet, including three-dimensional graphs, line, bar, stacked bar, exploded pie, and histograms. Users may choose from a palette of 16 colors and six type fonts. In addition, graphs may be transferred to the word processor or displayed in a slide-show format.

Ron Ferguson
Vice President of Marketing
Innovative Software
Lenexa, Kansas

We were dismayed to note the omission of *Microsoft Chart* in your recent blockbuster on business graphics ("Graphics Software on Display"). *Microsoft Chart* is clearly one of the leading packages on the market today for presentation graphics, and its omission was a serious oversight.

Microsoft Chart can import data directly from a variety of business software applications, including Lotus's 1-2-3 and Symphony, Microsoft's Multiplan, and dBASE III. *Chart* also provides a gallery of

45 preformatted chart types plus extensive formatting options to customize a chart. Finally, *Chart* supports a wide range of output devices, including dot matrix printers, laser printers, ink jet printers, pen plotters, and image recorders.

Jeff Raikes
Director, Applications Marketing
Microsoft
Redmond, Washington

We were very surprised to discover that you did not include our program, *Open Access II*, in your article "Graphics Software on Display." SPI began publishing *Open Access II* (then called *Open Access*) back in 1979. Our spreadsheet had graphics when other packages didn't even have spreadsheets yet. And more important than our longevity is the quality of our graphics.

Open Access II has the only true rotational 3-D graphics on the market. Referring to the Summary of Features table on page 124, it has every chart and graph type listed, with the exception of Gantt and organization charts. No other product reviewed can match that.

Lorraine A. Iverson
Manager, Corporate Communications
Software Products International
San Diego, California

Executive editor Bill Howard replies:

PC Magazine's single-topic issues often target all products within a category. We may apply filters to narrow the field to products that are new or markedly changed since the last review, that fall within price or performance categories (e.g., laser printers under \$3,000), or that are nontrivial (no Cassette BASIC accounting packages). Other magazines may look at only a handful of products, so if

they leave out three graphics programs, it's no big deal: they left out 40 others too. We can't make that excuse. Microsoft Chart, Smart Spreadsheet, and Open Access II fit the screening criteria and should have been included. In two words: we goofed.

CRACKERS NOT HACKERS

I take umbrage at Howard Marks's referring to unscrupulous, immature "crackers" as hackers, and I take you to task for permitting their unprofessional antics to be dignified by implying that such is the essence of hacking (sidebar "How 'Hackers' Break In," in "For Your Ears Only: PC Security Modems," *PC Magazine*, Volume 6 Number 4). It is bad enough that the news media have unwittingly spread such misconceptions among the public at large, but it is unforgivable for it to appear in a professional computer journal such as yours.

In my 20 years of working with computer software, being called a hacker has always been an honorable designation, on the order of being a programmer's programmer and having knowledge about the internal workings of computers. The fact that some "kids" have misapplied such knowledge does not excuse you for falling to the level of common newspapers.

Bob Stephan
Pebble Beach, California

Howard Marks replies:

While I am also concerned about this change in the meaning of the word hacker,



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- ☐ **EDUCATION 2**—Learn the Presidents, States (and capitals) and more. Color required.
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LETTERS

I'm afraid that most people, including most of our readers, would use this word to describe the type of people who break into computer systems.

FANTASYLAND IN REALITY

I thoroughly enjoyed Stephen Manes's column "The 386 in Fantasyland" (PC Magazine, Volume 6 Number 5)—the idea of a software revolution occurring because higher-speed computers are available does seem a bit presumptuous.

Mr. Manes made one small error in his article, however. He mentioned that a 1-megabyte, 1,024 by 1,024 resolution would display only eight colors. Actually, the 8 bits per pixel available in a 1-megabyte display would allow 256 colors to be displayed. Coupled with a palette chip, one could choose from more than 16 million colors. But even with this kind of equipment available I would not expect any kind of software revolution.

James Hughes
Houston, Texas

Contributing editor Stephen Manes replies:
Thanks so much for the correction. As punishment my computer will spend the rest of the day executing the following: 10 PRINT "8 bits = 256 colors, Manes, you dope!": GOTO 10.

In response to Stephen Manes's column, "The 386 in Fantasyland," I must express my feelings about the injustice that has been done to the 386 machines and to the people who may be in the same shoes I was in before my company purchased the 386.

Prior to our purchase of a Compaq 386, we had been running our accounting package on a PC compatible running in turbo mode at 8 MHz. With this machine, processing time was slow; it took 2 days to complete end-of-month processing.

Enter the Compaq 386, with an end-of-month processing time of only 5 hours. I can't express the extent of satisfaction we all feel. Although the chunk of money we paid for this machine was substantial for a small corporation, we would make the same decision tomorrow.

I feel it unfair that the many administrators of thousands of small businesses obtain false impressions that these machines

will do little for them at the present and completely ignore the benefits they may receive in the future. It is with this in mind that I suggest Mr. Manes take the time he saves on haircuts and shaves and devote it toward finding out what users of 386 machines are accomplishing. Maybe then we can set the record straight.

Robert Arbogast
Mount Sterling, Ohio

Contributing editor Stephen Manes's barber replies:

Hey, the column specifically said the 386 would benefit users who really needed extra speed; the main point was that more extravagant claims remain to be proved. So give me a break and learn how to read, okay? As it is, Manes won't ever come in for a trim because he's too busy answering letters from people who spend more time shaving than thinking.

THE WRONG IMPRESSION

In the article "Abort, Retry, Ignore" (PC Magazine, Volume 6 Number 1), you listed *Interlude II* first in a series of products that were referred to as "this year's collection of bugs, bombs, and backward moves." Recreational Technology has sold many thousands of copies of *Interlude*



II and has received virtually no complaints from users about technical flaws in the product. It is my understanding that you were attempting to spoof our advertisement, but to include it in a list of faulty products that were classified as the worst products of the year is unconscionable.

Jeffrey Brown
President
Recreational Technology
Houston, Texas

Indeed, we found no errors in the program.—Ed.

Annotations for the SeeMORE interface:

- Ordinary 1-2-3 display
- Enhanced 1-2-3 display with SeeMORE
- See up to twice as many columns
- Choose mixed font format (Top 3 lines big)
- Choose normal or reverse video
- Change colors (CGA, EGA, VGA)
- Print any compressed screen
- No special hardware required
- Switch to new size without leaving 1-2-3
- See up to twice as many rows

	Apr-85	May-85	Jun-85	Jul-85
Gross Sales	10,700	19,874	19,455	19,845
Less: Returns and Allowances	324	330	681	452
Less: Sales Discounts	256	272	275	284
Net Sales	10,120	19,272	18,499	19,109

	Apr-85	May-85	Jun-85	Jul-85
Beginning Inventory	1,000	1,322	1,144	1,140
Purchases (net of discounts)	8,000	10,511	12,540	12,444
Freight In	1,200	1,293	1,157	1,179
Less: Ending Inventory	1,000	1,322	1,144	1,140
Cost of Goods Sold	9,200	11,813	13,697	13,603
Gross Profit	9,200	7,459	4,802	5,506

1-2-3 never looked so good.

Introducing SeeMORE, a powerful screen manager for 1-2-3® that expands your worksheet view.

SeeMORE gives you a choice of compressed formats that double, triple or quadruple the number of cells displayed on the screen.

Quit scrolling around.

Install the SeeMORE program with 1-2-3 and you can build a twelve month forecast without stopping to scroll around. All twelve months appear on the screen.

And because so many cells are visible, trends and relationships become clear. SeeMORE lets you see the big picture.

SeeMORE manages the screen while you operate 1-2-3. You can switch to a new size or color without leaving your worksheet and you can produce a hardcopy print-out of any compressed screen with the push of a key.

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No special hardware is required to run SeeMORE. All you need is a CGA, EGA, VGA, Hercules or compatible graphics adapter.

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In all, Above Board 286 can give you up to 4 MB of expanded memory, based on the Lotus/Intel/Microsoft standard.

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And your pop-up utilities are popping up all over the place.

Then, when OS/2 finally arrives, that same Above Board you've come to know and love will give you up to 4 MB of OS/2 memory. Ready to run.

What's more, our new Above Board 286 comes with switchless installation, a five-year warranty and the toll-free technical support you'd expect from Intel.

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Because we're promising you the moon in the future.

And giving it to you in the present.

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LETTERS

MAILBOX SURPRISE

I would like to express my appreciation for the service given in providing me with a copy of your PC Labs Benchmark Tests. Before receiving the disk in the mail, I thought I would receive a printout to laboriously enter and compile or assemble. Needless to say, I was extremely surprised to find the disk in my mailbox. Kudos to you and your staff for providing both the tests and an immediate, useful way of implementing them. Please accept a whole series of "Atta boy's" from me in lieu of gold stars to pin on your lab coat lapels.

Richard B. Shepard, Ph.D.
Reading, Pennsylvania

The PC Labs Benchmark Tests disks are distributed at major computer shows and local user group meetings (when our editors speak to local user groups). You can also obtain a disk by requesting one from PC Labs at the New York address.—Ed.

CONFLICTING REVIEWS

In Volume 6 Number 1, Paul M. Stafford suggests that the Sony CPD-1302 Multiscan is the greatest thing on earth since sliced bread (First Looks, page 33), while in Volume 6 Number 6, Philip F.H. Rose asserts that the very same monitor is "well below the best" ("Behind the Screens: EGA and Multiscan Monitors").

No doubt you will find some way to weasel out of this bizarre contradiction, but which review should we believe?

David Kwiat
Hollywood, Florida

The article in First Looks was not a PC Labs-based comparison review, although comparison to the NEC MultiSync is inevitable. Personal tastes play a large role in preferring the appearance of one monitor over another, but these facts remain: The Sony uses a slot-line mask, in which the horizontal dot spacing is less than that of the MultiSync. The vertical spacing, because of the shape of the phosphor dots, is greater than the MultiSync's. Different graphics tests, user opinions, color tests, and macrophotography reveal the MultiSync to be preferable for most work. Yet the Sony easily outperforms it electrically. But then, you don't strike us as the shy type. Which would you rather use?—Ed.

CORRECTIONS/AMPLIFICATIONS

The correct model number of the TW Casper Corp. monitor reviewed in "Behind the Screens: EGA and Multiscan Monitors" (*PC Magazine*, Volume 6 Number 6) is TE 5154.

Webster's New World Writer ("Word Processors: More Power for the Money," *PC Magazine*, Volume 6 Number 4) has on-screen justification, triple-printed spacing, auto-reformatting as blocked text is reinserted, auto-backup, and both case-sensitive and insensitive search and replace features.

T.N.T. Software's *My Word!* ("Word Processors: More Power for the Money") does auto-pagination, has an "undo last delete" function, and reads and writes plain ASCII files. Its status line information will include the disk drive and the directory, the cursor can be moved to the beginning and end of a document with a single command, and the cursor can be moved directly to any line. The maximum file size is about 48,000 characters, and the current file directory appears on the screen before you edit a document. There is a time and date variable in mail-merge, and *My Word!* can exit without saving a document by using Ctrl-KQ.

System Facilities' *XPIP* DOS shell can copy, rename, move, delete, and change attributes for multiple files with tags ("DOS Shells Get Smarter," *PC Magazine*, Volume 6 Number 4).

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PC MAGAZINE
August, 1986
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CIRCLE 308 ON READER SERVICE CARD

10 BIG REASONS IT'S TIME YOU CHANGED YOUR EDITOR TO dBRIEF

1 FUNDAMENTAL TRUTH. If you are a programmer, you use your editor more than any other tool. If it isn't the best, the fastest, the most versatile, the most productive...well, then neither are you!

2 OUR ENTHUSIASM. While we do not publish BRIEF we wish we did. We sell so many BRIEFs that we've been advertising it non-stop since it was introduced two years ago. We're not alone in our enthusiasm. There is no end of accolades from other admirers:

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"Overall, BRIEF is an excellent and efficient editor with capabilities that are truly useful. If you're a serious programmer or developer of commercial applications, the BRIEF/dBRIEF package is one of the best investments you can make!" *PC Magazine*, 7/86

"Every time I've mentioned text editors I've got a raft of mail urging me to try BRIEF. Now that I've tried it I see why. It has windows—boy, does it ever have windows! It does just about anything you want it to. Look no further recommended." *Jerry Fournelle*, *Byte* 12/86

Best editor of 10 compared
Dr. Dobbs's Software Tools

3 WINDOWS ON THE WORLD. Why the excitement? First, BRIEF's architecture. Any number of files of virtually any length can be open. (Start BRIEF with "w*" to prove it.) Open as many tiled windows as fit the screen—over/under and side-by-side—to work on any of your files. Open, close, and resize windows as you go. In each window, full screens or tany, all editing techniques are at hand—high-speed cursoring, pinging up and down, horizontal scrolling, optional word wrap. Load the same file in any number of windows to view different areas simultaneously. A change in one changes all. Cut and paste text blocks between windows and files, or into buffers for later recall. All files stay in memory, so you can always go back to skip some more.

4 WHOLLY MACROS. Much of BRIEF is written in its own macro language. It is that powerful! The language and its compiler come with every copy, as do many standard macros, with source code for learning by example. It is a complete language with conditionals, loops, recursion, global and local variables, even data types. It can control files, windows, and the keyboard. It has structure, 32-character variable names, and—not at all like 1-2-3's* a cumbersome—entirely readable, like a hybrid of LISP and C. With it you can develop a library of routines to power BRIEF your way.

5 UNDO. NOT UN-DELETE. Don't confuse the two. BRIEF doesn't just keep snapshots of recent deletions should you want to pick them up from the cutting room floor. It can reel the whole film backward undoing any command that affected the cursor or the text. Watch it undo a global replace, for example. Uncutany. It can back up 300 times, all the way to the beginning of a session. "Works like a dream," said *The C Journal*.

6 SHELL GAMES. Leave BRIEF, run your compiler, print out the error messages, load up BRIEF again? No way! Run your compiler from inside BRIEF! It will point to each error line in your source program, still loaded in memory, for immediate editing. You don't have to leave BRIEF to use DOS either. BRIEF disappears from the screen to get out of your way, but say bye to DOS and BRIEF pops back to the screen, as do all the files you were working on.

7 KEY WHIZ. You can reassign BRIEF's command keys to whatever keys you're used to, even your old editor's, so you don't have to send your fingers back to school. Macro execution can be assigned to single keys. Or you can tell BRIEF to listen while you tap out a complex routine. It will save and playback faithfully, a shortcut macro without a single line of coding.

8 MULTI-LINGUAL. BRIEF's macro language is perfect for writing formatters for your language which indent, match up parentheses and brackets, and set up statement templates for full-in. BRIEF comes with C language support already built in. Others have written macros to format Pascal, BASIC, LISP, Prolog, FORTRAN.

9 QUICKER PICKER-UPPER. Looking for something? BRIEF has full UNIX*-like expression search tools to forage and find and fix any file in memory. Literal strings with wildcards and "?" character masking, sure. But also indifference to case or intervening characters, [a-z] to match all vowels, [a-f-m] to match character ranges, beginning or end of line searches, even multiple choice pattern matching and replacement.

10 REASONS 11 THROUGH 20: 11. BRIEF comes with a color option. You can select your own color scheme anytime. 12. It supports EGA's 43-line

dBRIEF. The Power Environment for dBASE Programming

Many worthy utility products supply needs that dBASE's programming language doesn't—dUTILTM, dFLOW™ and a host of others. To do it, you have to use them separately, then combine their output into your dBASE program files.

No longer dBRIEF™ writes in BRIEF's macro language, grabs hold of BRIEF and turns it into a complete dBASE III and III Plus programming domain. Using BRIEF's underlying shell capabilities and its own interfaces, dBRIEF can run external utility libraries, plus dBASE, itself, and link to the Clipper™, Foxbase™, TM and Quickset™ compilers, all with dBRIEF still loaded and running the show. It can do what BRIEF already does plus:

- Convert a screen layout into dBASE code for interactive data entry
- Display dBASE file structures in windows, a great convenience alongside your program files
- Expand keystrokes into full dBASE statements
- Indent automatically for cteq display
- Create databases, index files, invoke Ashton-Tate's dFORMAT™ and dCONVERT™, draw lines and boxes

*Simply marvelous programming environment for writing and editing dBASE programs. *PC Magazine*, 7/86. Source code included!

Requires BRIEF 1.32 or later and 384K 5.25K to run dBRIEF within dBRIEF. 640K and hardisk recommended.

mode and can display up to 128 lines long. 13. Full 8-bit ASCII display, the whole character set can show on screen. 14. Full path support. 15. Command line start-up flags to modify BRIEF's behavior, change a path name, or run a macro: for example "wp" which turns BRIEF into a word processor with wraparound and margin setting. 16. Automatic file save during idle moments. 17. Compatibility with most stay-resident programs (like Schedule™), multitaskers (like Microsoft Windows™), and networks. 18. A bulletin board with public domain macros contributed by a mushrooming cult of macrocrackers. 19. No copy protection. 20. Context sensitive help, and phone support from the publisher.

*BRIEF needs 32K normally, 320K for complete feature. *Product must be returned in resalable condition.

NEW VERSION 2.0! Support for more languages • Regular expressions match over multiple lines • Faster undo & expression search • Added types of block marking • Optional borderless windows • Supports displays with 127 lines, 255 chars • New documentation with tutorials on regular expressions and macros
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Interactive-C™ shows how far C interpreters have come. More than an interpreter, Interactive-C is a fully integrated development environment: a complete K&R interpreter, debug tightly to its own editor and "the best debugging features of any interpreter," says Computer Language, 2/87.

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Run Interactive-C using adjustable edit, command, and status windows. Toggle a second screen showing only your program's output—never any crowded intermediary. Or, use two CRTs. Load object code of your compiled functions or commercial libraries. Interactive-C has immediate mode, syntax checking both as you type and run, and cursor positioning that points precisely at an error.

Plus, you can port programs from Interactive-C to most computers with no modifications—its 100% compatible. Ask for D0590, List \$240. PC Brand \$219.

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The premier graphics library that got the ball rolling for PC-based graphics, but grew so omnipotent that it supports over 25 graphics boards—including IBM's EGA and Ne 9 Revolution's six series—and has a multitude of mouse and pen drivers. All that in each box. Separate C versions for Lattice, Micro, Aztec, C186. What does Halo-Halo do? A down to the last pixel graphics library plus functions to reset drivers so another program can run on anything. Wonderful value for single license. Costly royalties though for redistribution. Sincerely 50345 & Language List \$360, We \$219. With Dr. Halo II a three-standing "pair," List \$440, We \$239.

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DBC™ takes C to dBASE. It creates and maintains files and their indexes which exactly replicate dBASE file design. So dBASE can read and update them. And the reverse: dBC can use any files created by dBASE. Now C and dBASE can operate on the same data bases interchangeably. On open dates the widespread culture of dBASE installations to exploitation by C programmers. Tap that market: add the resident dBASE language, and gain the advantages of C with this single product. dBC's functions parallel all dBASE file handling commands, many decomposed to give closer control. Each backed by demo source files on disk.

WINDOWS for C/WINDOWS for DATA Microsoft Windows™ and TopView™ Compatible

Windows for C™ is a library of over 80 functions to add the power and practicality of window platforms to your application. Unlimited windows, each defined in a C structure for easy reference throughout your program, can be made either for pop-up or permanently overlaid on the screen. Windows scroll and highlight lists with arrow keys, will read and scroll ASCII files vertically and horizontally in windows, and even write to memory-mapped files of the screen.

Logical treatment of video attributes permits unchanged programs to run on color or monochrome. Colors of windows are set individually. All functions are in separate modules. Only those used are linked. Only buffers holding on-screen or temporarily obscured windows occupy RAM, others released dynamically.

Windows for Data comprises all of Windows for C, but takes in data through the windows as well. At the high level a single function lets you specify prompt string, field length, target type, screen location, picture, data variable, then sets lesser functions to carrying to get and process a user's data. There are utilities to get system date and time, mess with strings, create your own masks for fields. Field options can require or prevent entry, keep on small or overflow.

keystrikes, and attachment of field-specific help messages and functions you want called to display messages or window entries. And you decide which keys will clear a field, jump to the next or prior, quit, etc. Clear messages to boot speed. Complete List for PC Brand \$195 \$149. T0100 Windows for Data \$295 \$259.

MICROSOFT C 4.0

A Great C Battle Rages and You're Winning

I bundles a source debugger and a memory editor, and sports a "huge" memory model permitting single data objects larger than 64k, but what's really impressive about Microsoft C are the benchmarks reported in Dr. Dobbs' Microsoft runs away from a field of 17 winning 11 of 27 benchmarks.

The Code View™ debugger uses Windows to show you exactly where on-screen source code alongside disassembled object, variables stack and registers. Drop down windows observe learning of commands. A source-level debugger that puts the rest to shame," said Dobbs.

Microsoft C has five memory models for code and data, plus non-library sup-

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We refund the purchase price of any product returned within 30 days on an entirely resalable condition. You can even try our programs themselves! If product code begins with E, T or L, though N— even if it means breaking the disk seal. Some developers do prove more popular for products, beginning with other letters, opening sealed code disks constitutes acceptance. But you can at least review the manual. There's just nothing stopping your buying from PC Brand.

port for another thirteen, and boasts alternate math packages for speed versus accuracy, with or without 8087/80287 chips.

Both linker and library manager are part of the package, as is the "make" which knows how to rebuild any size project by compiling only elements which have changed. It is repeatedly used by Lotus, Ashton-Tate and, intriguingly, Microsoft to develop Windows. Dobbs calls it the best MS-DOS C development environment value today for virtually any kind of program conceivable. 32k/s suggested.

Ask for C0500 List PC Brand \$450 \$295.

C-TREE & R-TREE

B-Tree File Manager Now Has Report Generator

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C-tree even comes in C source code yet there are no royalties. Source sticks to K&R so C-tree is portable. Tests in many environments prove it. C-tree permits any number of keys for a data file—alpha, numeric, even floating point. It handles files with varied record lengths and keeps both host and user's file. Has both high-level ISAM routines to handle details

with minimum coding and decomposed step-by-step functions you can access directly. In short, you get the works.

r-tree: thousands of c-tree users (and you) have had a suddenly expanded ability to produce ad hoc reports from files maintained by c-tree (v 4.1 and up). Just link the file description to the r-tree library and all you need is an ordinary text editor to write any number of report scripts with no further C coding. Reports can access data in several files, select on criteria, join the

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c-tree F0500 List PC Brand \$395 \$329. c-tree F0505 \$295 \$245. Combined \$690 \$541.

POLYTRON VERSION CONTROL

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Source Print

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...and Tree Diagrammer

Tree Diagrammer prints an organization chart of your program's structure showing the hierarchy of function, procedure, and subroutine calls. Shows at a glance what routines call each other for clearer debugging. Every shop should have this important documentation tool. List \$55 Ours \$45

GREENLEAF LIBRARIES

Functions

C source, assembler source and binary libraries of 225 functions for many programs. Streamlines tiny functions, groups to number, loading code your application may never use. Manual's 250 pages help select functions, as do demos, bulletins board. Has DOS exec for file and directory. Screen tools for clearing, scrolling, cursor, color, panel access. String operations to add, delete, sort, string pointers for top speed. Plus graphics primitives: key, board status, F-key assignment, time/date, read registers, get memory size, peek, paste, pretty more. Specify computer last. List \$185 Ours \$130

Communications

Communicate from within your own C programs! Over 120 functions and demo programs in C and assembler source to set up interrupt-driven async communications for up to 16 channels. Up to 10 baud, ASCII or binary, any parity or word length, 8250 UARTs, Xon/Xoff and Xmodem. Wide/Trace receive. Goodbye separate communications software. Specify computer last. List \$185 Ours \$130

RUN/C Interpreter Links Binary Libraries

Run/C Professional™ has a screen interface as simple as PC BASIC with full-screen editing and familiar commands like LOAD, LIST, MERGE, even TRON and TRACE. Just write and RUN.

Best of all a dynamically loaded potentially any major commercial function library compiled with Lattice's large model (\$12k recommended and Lattice C required for external libraries).

Lots more features system interrupts, a shell command interpreter and any operating system command without exiting, built-in debugging aids. Ask for S0950 Last. \$250 PCB \$185.

PANEL PLUS

There are no screen design and data entry tools quite like Panel Plus. Design a screen under program control use Panel's utility to run and test it. Field by field then pass it to the code generator which delivers C source code. Options style the code to your computer's liking. Then do whatever you want in the source code afterward. The code calls Panel Plus's function library, but now the library comes in source, so everything produced is highly portable. Not like screen managers that deliver object classes leaving you to write the detailed code.

A single screen design can have 100 fields stacked as visual overlays up to

Source For Complete Portability

127 levels deep or as pop-ups. Each field can be boxed, colored, multi-row word-wrapped, scrolled both ways if larger than its view exposure, assumed a help and error message, except only certain characters or match a picture, check data after entry—proper dates, number ranges etc.—or adjust your own validation routines. Customize Panel's vast utility with these routines.

Panel Plus will operate in graphics mode via interfaces to graphics products it supports. Handles EGA's 40 line screen. Assigns to various keyboards screens, operating systems. Major tool for the serious developer. List \$495 PCB Brand \$395

BASTOC OPTIMIZES!

Translates BASIC Into C

For a trifling price, BASTOC™ moves truckloads of BASIC code over to C. It's a translator which takes in Microsoft Extended BASIC and emits pure K&R for Microsoft or Lattice. Structures even controlled BASIC code. Optimized to dramatically reduce execution time. Converts to integers those variables in BASIC programs which do not need floats. Where BASIC uses full assignment statements to increment counters, BASTOC converts to C's compact form. Dynamic storage allocation and BASIC's selective garbage collection. Huge workspace. Ask for S0373, List \$495 PCB Brand \$395

Shopping List for the Power Workbench

ASSEMBLERS & DEBUGGERS		LIST		SCREEN DESIGN		LIST	
Advanced Trace-86	Morgan, ASM interpreter	175	119	Curses by Lattice, UNIX screen designer	with Source	125	90
C-Sprite Debugger by Lattice	source level	175	139	Greenleaf Data Windows	New	250	169
Microsoft Macro Assembler with Utilities		150	109	with source		395	287
PAS-M86 by Phoenix, Micro Assembler		195	125	Panel Plus by Round Hill, no royalties	New	195	149
Periscope I Debugger from The Periscope Co		345	299	View Manager for C by Bliss		275	164
Periscope II w/NI Breakout Switch		175	139	Vitamin C by Creative Programming		225	198
Periscope II w/NI Breakout Switch		145	105	VC Screen by Creative Programming		100	81
Plus86 Plus by Phoenix, Symbolic Debugger		395	335	Windows for C Varmint Creative Software		195	149
BASIC LANGUAGE				Windows Data Management Consultants		245	175
Microsoft BASIC Interpreter for XENIX		350	295	GRAPHICS			
Microsoft QuickBASIC Compiler with full BASIC		99	69	Essential Graphics by Essential, no royalties		250	210
Professional BASIC by Morgan		99	69	GSS Graphics Development Toolkit		495	375
BORLAND PRODUCTS				GSS Kernel System by Graphic Software		495	375
Relief & Relief Workshop		200	129	GSS Metafile Interpreter		295	235
Relief Data Base System		150	89	Halo by Macro Graphics		390	149
Relief Workshop		70	45	with Dr. Halo II		440	299
Turbo Basic	New	100	64	Halo for Microsoft includes all fonts		595	434
Turbo C Compiler	New	100	64	COMMUNICATIONS			
Turbo Lighting		100	64	Asynch Manager by Baisie, for C or Pascal		175	117
Turbo Pascal & Tutor	New	125	65	Greenleaf Communications by Greenleaf		165	138
Turbo Pascal with SORT & BCD		100	64	P/Tel by Phoenix, Binary File Communicator		195	115
Turbo Tutor		40	24	UTILITY LIBRARIES			
POLYTRON PRODUCTS				Blaize C Tools Plus		175	117
PVCS Corporate..... Source Code Control Syst		395	309	Blaize C Tools		125	89
PVCS Personal		149	109	Blaize C Tools 2		100	67
PVCS Network		149	109	C Food Screenshot by Lattice		150	109
PolyLink Complete Make Utility		99	73	C Utility Library by Essential, 300 functions		165	138
PolyLibrarian II Library Manager		149	109	Greenleaf Functions by Greenleaf		395	335
PolyREF Protolink Linking and Shell		149	109	FlorC by Phoenix, vet library		395	335
PolyREF Complete Cross Ref Utility		129	99	DEVELOPMENT TOOLS			
PolyREF One language only		129	99	Code Sifter by David Smith Software, Profiler		119	69
PolyBoost The Software Accelerator		85	64	C-Worthy by Custom Design Software		225	269
PolyDesk III 3rd Generation Desktop Org		99	73	C-Worthy for Network Manager, help, emps		499	449
PolyDesk III Add On Tools		99	73	Dan Bricklin's Demo Program Prototype		75	69
C COMPILERS				LMK from Lattice by Lattice, "make" like UNIX		195	149
C66 PLUS by Computer Innovations	New	497	387	Microsoft Windows Development Toolkit		450	369
Lattice C Compiler from Lattice		500	299	PC Link by Gimpel Software, under UNIX's "inf"		139	125
Let's C Compiler by Mark Williams		75	55	PFinish by Phoenix, EKE performance analyzer		395	335
with CSD Source Level Debugger		125	90	Plus86 Plus Utilities memory for overlays		445	325
MWC-86 Mark Williams C Development		495	389	Prasher by Phoenix, like UNIX "make"		125	85
Microsoft C Compiler 4.0		450	395	Pre-C by Phoenix, UNIX "inf" alike		295	155
C INTERPRETERS				Prattley PC plus Phoenix products	New Price	995	Call
C-Terp by Gimpel Software		300	249	OTHER TOOLS			
Instant C by Rational Systems		500	395	BASTOC by JMI, convert BASIC to C		495	399
Interactive C by IMAC with debugging		249	219	BASIC-C BASIC's functions added to C		175	139
RUNC Professional from Lattice		250	185	Report Option by Softcraft, Btrieve Report Gen		145	126
RUNC without Loadable Libraries		120	109	Xtrieve by Softcraft, Query Utility for Btrieve		245	220
TEXT EDITORS				FORTRAN COMPILERS & UTILITIES			
Brief from Solution Systems		195	Call	RMFORTRAN by Ryan McFarland		595	Call
Ed by Emeryng Tech. Multi-screen		155	119	ACS Time Series by Alpha Computer Service		495	405
Epitron by Leguero Software, like EMACS		195	149	Fortib Plus by Alpha Computer Service		70	45
FirstTime by Spruce Technology, C syntax		295	229	Microsoft FORTRAN Links with Microsoft C		450	369
Kedit by Mantis/Well, similar to Xedit		125	99	Microsoft FORTRAN for XENIX		695	548
SE, the Lattice Screen Editor Multi Window		125	99	Scientific Subroutine Package by Alpha		295	239
PMate by Phoenix, with Macros		195	115	The Statistician by Alpha Computer		295	239
Text Management Utilities Grep, split, diff, etc		120	100	Strings & Things by Alpha Computer		70	45
with source		150	99	OTHER LANGUAGES & UTILITIES			
Vedit Plus by Compuview		185	129	RMICOBOL by Ryan McFarland		950	Call
FILE MANAGERS				RMICOBOL 68 ANSI/85 COBOL		1250	Call
Brieve by Softcraft, no royalties		250	195	Source Print... source code formatter		75	60
Brieve Network by Softcraft		495	465	Tree Diagrammer... source code diagrammer		55	45
C-Tree by FairCom, no royalties, source		395	329	Microsoft COBOL Compiler		700	499
R-Tree by FairCom Report Generator		295	245	Microsoft COBOL Compiler for XENIX		995	795
C-Tree & R-Tree Combo by FairCom		650	541	Microsoft COBOL Tools with Source Debugger		450	333
dbC from Lattice, maintains DBASE files		250	195	Microsoft COBOL Tools for XENIX		450	333
with source		450	390	Microsoft LIP New Common Lisp		250	189
dbC In Plus, supports multi-user DBASE		750	595	Microsoft MultiMath includes MultiSim		300	199
with source		500	1185	Microsoft Pascal Compiler Links with M'soft C		450	369
dbVista single user DBMS by Reima		495	399	Microsoft Pascal Compiler for XENIX		695	548
dbVista multi user DBMS		495	399	PDisk Phoenix's new disk manager		195	125
Opti-Test Sort Can sort Brieve files		149	105				

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■ GUS VENDITTO

PC ADVISOR

Help in accessing expanded memory with software, in doing financial calculations, in finding a low-cost CAD program, and in sharing disks with the Personal System/2.



EMULATING EXPANDED MEMORY

I am looking for a program that will allow a portion of my hard disk to emulate expanded memory. I know that RAMdisk software, which allows memory to emulate a disk drive, is commonly available, but I need the reverse.

Andy Laurence
San Diego, California

There are three programs that can do it.

Micro VMS (Vericomp, San Diego, Calif.; (619) 277-0400; \$75) and Above-Disc (Tele-Ware West, Seal Beach, Calif.; (800) 654-5301; \$99.95) are fine, as long as you don't use a print buffer in extended memory.

V-EMM (Fort's Software; Manhattan, Kans.; (913) 537-2897; \$89.95) has the most to offer; it was an Editor's Choice when PC Magazine looked at expanded memory emulators in the March 13 issue (Volume 6 Number 6). It has fewer compatibility problems than others in its class; V-EMM's only limitation is that it must use the hard disk's BIOS, and so it cannot be used with hard disks that do not have an IBM-compatible BIOS on the controller. Most hard disk controllers sold for PCs are compatible (including the popular ST506), but if you have any doubt, check with Fort's Software before you buy it.

FINANCIAL PROBLEM SOLVING

I'm an accountant and I do lots of financial planning for my clients. I find myself doing many of the same equations over and over. You recently recommended a scientific calculator; are there any RAM-resi-

dent calculators with built-in financial equations?

Thomas E. Suarez
White Plains, New York

I know of two good grab bags of utilities that may help.

Metro (Lotos Development Corp.; Cambridge, Mass.; (800) 882-4432; \$85) is an assortment of RAM-resident utilities, including a file manager, an outo-dialer, and a list manager. What sets it apart from other such SideKick-like utilities is a calculator that throws in problem solving for net present value, internal rate of return, present value, and future value.

Finance 10 from Creighton Development (Irvine, Calif.; (714) 472-0488; \$149) calculates loan amortizations, depreciation (residential and nonresidential real estate, certified historical structures, rehabilitation projects, and luxury automobiles), lease-versus-purchase analyses,

internal rate of return, IRA evaluation (total value at retirement, monthly annuities, and so on), statistical analyses (standard deviation, and so on), and bond yield analyses (before tax and after tax).

It's RAM resident, has a simple, fill-in-the-blanks style, and lets you paste figures into (or from) your applications program.

LOW-COST CAD

I've been told that a CAD program could help me save lots of time doing floor plans. We're constantly shifting the layout in our showrooms, so I need to do blueprints monthly. I looked at AutoCAD and CAD-Vance but was put off by the cost and complexity. I don't need to do this on a computer so badly that I want to spend over a thousand dollars and invest several weeks learning a new program.

Mark Lenke
San Diego, California

A couple of good introductory packages are available from leading CAD (computer-aided design) software publishers just to help in situations like your own.

The maker of AutoCAD produces AutoSketch (AutoDesk; Sausalito, Calif.; (800) 443-0100; \$149), a greatly simplified version of its league-leading heavy hitter. Generic Software has developed First CADD (Redmond, Wash.; (800) 228-3601; \$49.95) to introduce you to the ways of on-screen design.

If you want to invest the hours but save the dollars, there are a handful of inexpensive CAD programs that have a solid base of powerful features. ProDesign II

■ **Finance 10 is RAM resident, has a simple, fill-in-the-blanks style, and lets you paste figures into your applications program.**

■ PC ADVISOR

(American Small Business Computers; Pryor, Okla.; (918) 825-4844; \$299.95), and Generic CADD (Generic Software; Redmond, Wash.; (800) 228-3601; \$99.95), would be good choices.

SIMPLER dBASE REPORTS

I find myself spending far too much time printing reports from my dBASE databases. Is there a simpler database for printing these listings?

William McCauley
Baltimore, Maryland

If printing reports is your only source of discontent with dBASE, don't switch. R&R Relational Report Writer cuts through dBASE's tedious report requirements. R&R lets you define a report's structure by pointing the position of headers, footers, and summaries on-screen. (Concentric Data Systems Inc.; Westborough, Mass.; (800) 325-9035; \$99).

■ **The Personal System/2 Model 30** uses 720K-byte, 3½-inch drives that are fully compatible with the drives used in most laptops.

SHARING IBM PS/2 DISKS

Will the 3½-inch floppy disk drives on IBM's new Personal System/2 Models 30, 50, 60, and 80 be able to work with the 3½-inch disks that are used by my laptop?

Or will I have to contend with buying other disks and copying my files?

Joe Gomolski
Colorado Springs, Colorado

Yes and no. The Personal System/2 Model 30 uses 720K-byte, 3½-inch drives that are fully compatible with the drives used in most laptops, including the PC Convertible, NEC's MultiSpeed, Toshiba's 1000 Plus, and Datavue's Spark.

Personal System/2 Models 50, 60, and 80 use 3½-inch drives that will read 720K-byte disks, but that are designed to write at 1.44 megabytes. Thus these models require special, high-capacity disks.

ASK THE ADVISOR

Send your questions to the PC Advisor, PC Magazine, One Park Avenue, New York, NY 10016. Please specify the precise equipment you are using when describing problems.

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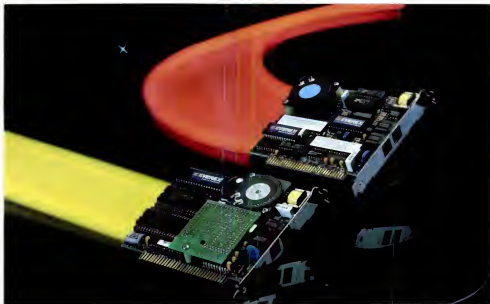
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* 300/1200 baud	YES	YES	* 300/1200/2400 baud	YES	YES
* SW VCL control	YES	NO	* Runs in slot 8 of IBM XT*	YES	NO
* Runs in slot 8 of IBM XT*	YES	NO	* Runs with all versions of Smartcom II*	YES	NO
* Runs with all versions of Smartcom II*	YES	NO	* Runs with multi-line phones	YES	NO
* ROM test on command	YES	NO	* Phone-off-hook detect	YES	NO
* Simplex communication	YES	NO	* Auto data-to-voice switching	YES	NO
* Phone-off-hook detect	YES	NO	* Allows "at" in lower case	YES	NO
* Auto voice-to-data switching	YES	NO	* Format (speed & parity) ID on command	YES	NO
* Format (speed & parity) ID on command	YES	NO	* Speed Mismatch message	YES	NO
* Speed Mismatch message	YES	NO	* Adaptive dialing	YES	NO
			* Leased line operations	YES	NO
			* Programmable response to DTR	YES	NO
			* CCITT guard tones	YES	NO
			* Self-test (RDL)	YES	NO
			* Installation program	YES	NO

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287 FaST 6—full speed 6 MHz	\$249

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Math coprocessors for PC/XTs & higher speed compatibles:

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FIRST LOOKS

IBM Model 60: Towering, Expandable Powerhouse

PC HANDS ON

BY WINN L. ROSCH

Despite its skyscraper case, the Personal System/2 Model 60 is more a bridge than a tower. Although it is currently perched at the top of IBM's PS/2 line, when the 80386-based Model 80 goes on sale later this year, the Model 60 will then stand between IBM's state-of-the-art personal computer and the less-expensive desktop Model 50.

From the Model 80, the Model 60 borrows its cabinet style and wide choice of expansion and mass storage options. From the Model 50, it borrows 10-MHz, one-wait-state performance and a 16-bit data bus.

The Model 60 features the Personal System/2's new VGA display modes—including EGA compatibility—as standard equipment; only the PS/2 analog monitors are optional. The system unit has a 3½-inch, 1.44-megabyte disk drive, a 40-megabyte hard disk, and room for two more drives.



Although similar performance and features make the Models 50 and 60 look like twins, they are completely dif-

ferent computers. The Model 60 system board and chassis—even the philosophy behind it—differ widely from those of

its lower-priced sibling. While the Model 50 is a preeminent high-performance, single-user machine, at heart the Model 60 is a multitasking computer (just as soon as it can run OS/2 sometime next year) or a multiuser computer designed for shared resource applications where the full power of a 386-based computer is not needed. Unlike earlier IBM standup computers, such as the AT, the Model 60 was designed from the start as a vertical system.

Two foot-wide feet are permanently attached to the all-plastic 24- by 19- by 6½-inch case, although they can be rotated out of the way for transport or storage. Moving the somewhat

(continues on page 24)

Handscan Reads Text Line by Line Directly into Applications

PC HANDS ON

BY TOM STANTON

Saba Technologies has come up with a mouse-size OCR (optical character reader) that scans and inputs text directly into spreadsheets, databases, and documents. Unlike most OCRs, which scan whole pages of text, the Handscan is a hand-held device that lets you select the text you want to scan.

I've tried two hand-held

scanners before and was disappointed, but the Handscan is a solid, well-built system that tolerates a reasonable amount of misalignment and still delivers accurate characters from the page to your PC. The Handscan system includes a mouse look-alike, a full-size XT interface card, software, and a font library that includes most of the common typewritten and letter quality typefaces (a future software release will support dot matrix fonts as well); like most

scanners, it cannot read typeset material (including magazines and newspapers) or any printing that is proportionally spaced.

Scanned characters can be swapped for other characters, converted into keyboard commands, or ignored. There is also a numbers-only scan mode that ignores most alphabetic characters but scans numbers and related symbols. You can create files that store settings and mouse key macros for specific

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PS/2 Model 60

(continued from page 33)

heavy (40-pound) system is made easier by a fold-down full-length carrying handle built into the top of the case. Although modular, the Model 60 is more conventional in concept than the Model 50, since it is bolted rather than snapped together.

Several of the Model 60's subsystems—such as the combined 3-inch speaker/battery holder and floppy disk drives—are directly interchangeable with the Model 50.

Matching the rest of the PS/2 line, standard equipment in the Model 60 system board circuitry includes a floppy disk controller, a serial port with a maximum data speed of 19,200 bits per second using an XT-style male DB-25 connector, a parallel printer port, and an input port for a pointing device (mouse, touchpad, or trackball). As with the Model 50, the VGA display system is also built in. Basic memory is 1 megabyte, contained in four 256K-byte memory modules, split 640K for DOS and 384K for expanded memory. RAM can be expanded up to the 16-megabyte limit of the microprocessor using expansion boards.

In addition to the 128K bytes of socketed ROM and 64 bytes of configuration memory in the system board clock chip, IBM has added an extra 2K bytes of

PS/2 and OS/2 Threaten Current LAN Standards

PC ANALYSIS

BY FRANK J. DERFLER, JR.

IBM's introduction of the Personal System/2 and related peripherals, coupled with simultaneous announcements from Microsoft about its intention to develop OS/2, have created short-term turmoil and long-term changes in the LAN (local area network) market. The turmoil comes from hardware incompatibilities. The changes come from software developments hinted at in Microsoft's statements.

As network workstations, the IBM Personal System/2 computers make 3Com's management look psychic. The company pioneered the development of a small, fast 80286 workstation that uses highly integrated circuitry and efficient

connections between the video, CPU, and network interface. The new IBM and 3Com products fit into the same mold.

As network servers, the new IBM machines don't offer advantages over other presently available 80286 and 80386 systems other than tighter integration between the processor and mass storage. In theory, this means better throughput, but other inefficiencies, such as hard disk accesses, slow things more than does internal data transfer.

If server manufacturers feel relatively secure, makers of network interface cards and gateway cards feel threatened. Like all other circuit board manufacturers, makers of network interface cards are going to have to rush development of new PS/2-compatible products. Their engineers will be thrilled with the

idea of many new DMA (direct memory access) channels being made available, but they will puzzle over how to allocate the channels among devices and over the memory-management techniques that will be used under OS/2.

Companies such as 3Com, Novell, and Banyan that replace MS-DOS on the file server with their own multitasking multi-user operating system will have to work hard to develop operating systems able to use the more powerful of the PS/2 PCs as network servers. While the new systems have no clear advantages as servers, PS/2 compatibility will certainly become an item on some buyers' checklists. Banyan's use of the UNIX operating system should allow it more alternatives than the other companies. 3Com has indicated that it might have to return to UNIX.

Paradoxically, DEC's strong tie to Microsoft's MS-NET operating system puts it in an excellent position to integrate the Personal System/2

battery-backed-up CMOS that can be used for such things as storing passwords for hardware access control. The Model 60 system board includes eight 16-bit bus Micro Channel Architecture expansion slots. One of these is occupied by the stan-

dard-equipment hard disk controller. Another slot has an extra 20-pin extension on its connector to allow add-in graphics coprocessors to access the system board video circuitry. Standard disk memory includes a single 1.44-megabyte, 3½-inch floppy

disk drive, with an additional bay for a second.

Two configurations are offered by IBM: Model 60-041, with a 44-megabyte hard disk, and Model 40-071, with a 70-



Benchmark Tests: IBM Personal System/2 Model 60 vs. 8-MHz IBM PC AT and Compaq Deskpro 386

The 10-MHz Personal System/2 Model 60 matches the PS/2 Model 50 (reviewed last issue) on every test except hard disk speed, where the Model 50 proved to be a slug. Compared here with two PC standards, the 8-MHz IBM PC AT and Compaq Deskpro 386, the Model 60 finishes where you would expect a 10-MHz 286-based PC to finish: right in the middle.

Performance Times

(Times given in seconds except where noted)
NOP

	80286 Instruction M/s	Conventional Memory	Floating-Point Calculation (milli-seconds)	80286 Disk Seek (milliseconds)
8-MHz IBM PC AT	4.2	9.0	1.3	35.6
IBM PS/2 Model 60	3.4	7.1	1.0	29.2
Compaq Deskpro 386	2.1	4.2	0.7	15.5

The NOP benchmark test is designed to measure raw clock speed and memory access time while minimizing differences in microprocessors and the effect of memory caching. This test executes almost nothing but NOP ("No Operation") machine code instruction in a big 128K loop.

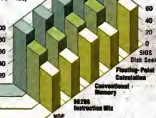
The 80286 Instruction M/s benchmark test measures the time it takes to execute a selected series of processor-intensive tasks. The test program uses 80286 instruction code. These instructions are a subset of the total processor instruction set.

The Conventional Memory benchmark test allocates 256K bytes of conventional memory and reads it as a series of 64K-byte records, then 16,384 random records are read into and written from this memory. The result shown is the average of the read and write times.

The Floating-Point Calculation benchmark test measures processor speed by looping through a series of floating-point calculations, including multiplication, division, exponentiation, and logarithmic and trigonometric

functions. The benchmark program uses the floating-point library included with Microsoft C Compiler 4.0. The 80286 Disk Seek benchmark test measures the time it takes to do a random seek using the disk's ROM BIOS. The test result includes minimal software overhead and may not parallel the manufacturer's claimed average access times. The test program performs 1,000 seeks. The average result is shown in milliseconds.

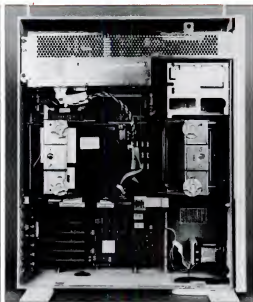
Relative Times (Ratio: IBM PC AT = 100)



computers into LANs with DEC VAX servers. DEC has extended its architecture to MS-DOS-based systems, and it, like Ungermann-Bass, can connect the new systems into networks through their serial ports without worrying about the vagaries of the new bus architecture.

The interprocess communications capability of the MS-OS/2 LAN Manager is described by Microsoft's Bill Gates as opening "the door for a new generation of truly distributed software." Combined with "easy integration" between the MS-OS/2 LAN Manager and Xenix, NETBIOS might be moving out the door in favor of more-sophisticated network "pipeline" communications processes.

This move away from NETBIOS comes at a time when companies, academic groups, and federal government agencies have finally established guidelines for a consistent integration of the NETBIOS interface and the DOD TCP/IP protocol standard. [E]



The 40-pound Model 60 system unit has a collapsible handle and legs that swing into position. There are eight Micro Channel Architecture slots; one is used by the ST506 hard disk controller. The video controller, floppy controller, 1 megabyte of RAM, and parallel and serial ports are on the system board.

megabyte disk that is not yet available but will list for \$1,000 more. The smaller hard disk uses the ST506 interface and achieves AT-like performance with an average access time of under 40 milliseconds. The larger hard disk will use an

ESDI (enhanced small device interface) device that transfers data twice as fast as the smaller one, 10 MHz instead of 5.

The Model 60 has two internal full-height, 5½-inch drive bays for mass storage expansion. Either of the standard-

equipment drives requires a full bay. The other bay has optional front panel access, so it can be used for a second hard disk, a WORM optical cartridge system, or a tape backup system.

Earlier IBM displays are not compatible with the analog sig-

PC FACT FILE

IBM Personal System/2

Model 60

IBM Corp.

(Consult your local authorized IBM dealer)

List Price: \$5,295

Requires: DOS 3.3, PS/2 analog display.

In Short: The Model 60 is IBM's 16-bit Personal System/2 tower; its basic features are similar to the Model 50, the major exceptions being a hard disk that is twice as fast, four extra Micro Channel Architecture expansion slots, and room for two more disk drives.

CIRCLE 430 ON READER SERVICE CARD

nals of the VGA standard. However, the VGA system and the Model 60 are software compatible with previous IBM video standards, and most programs should operate with the new display system without problems. For its four additional expansion slots, better disk drive, and greater expansion options, IBM charges \$5,295, a \$1,700 premium over the Model 50.

For single-user systems, which make sense only for the most voracious power users, the Model 60 can be a good choice. [E]

The Personal System/2: How Much of a Bargain?

PC ANALYSIS

BY BILL HOWARD

The Personal System/2 offers innovation, but whose PCs provide the best bang for the buck? The new IBM? Old IBM? Compaq? The mail-order compatibles?

If you factor in the extra I/O and video controller on the PS/2 motherboards, the PS/2 family costs roughly 10 to 20 percent

less than the previous generation of EGA-equipped PCs. That's low enough to put pressure on Compaq and to give pause to the name-brand compatibles (NEC, Sperry, ITT, AT&T), but not enough to seriously challenge the mail-order compatibles. Yet.

Consider IBM's successor to the AT, the 10-MHz 80286 Model 60. At \$5,295 with a 44-megabyte drive, it compares favorably with a 40-megabyte,

12-MHz Compaq Deskpro 286 at \$4,995 plus \$595 for an EGA card. PC's Limited sells a similar 40-megabyte, 12-MHz machine with EGA card and monitor for \$3,595. The clear nonbargain is the older line of IBMs, even after 10 to 20 percent price cuts. For instance, the 8-MHz, 30-megabyte AT 339, reduced by \$700 on April 2, costs \$4,595 now but lacks a video board.

IBM's most attractively priced model, the \$1,695 Model 30 with two floppy disk drives and an improved XT-level 8086 CPU, suffers from a crippled video chip. You're forgiven if you call this model the PS/r. What else can you call a ma-

chine that gives you a choice of 256,000 colors at the highest resolution—but only lets you use two of them? Ditto for the floppy disk drives, limited to 720K bytes when everything else in the line offers 1.4 megabytes. Clone makers could have been crippled by a \$1,000 entry-level machine—not by this one.

IBM's big investment in a strategy of fewer chips doing more work and in highly automated manufacturing facilities means IBM is among the lowest-cost producers of PCs. Once the supply line fills, a significant round of cost-cutting could put IBM back in the driver's seat. That's when the competition really has to watch out. [E]

JDL-850 EWS: A 24-Pin Printer That Can Double as a Plotter

PC HANDS ON

BY GLENN HART

Can a dot matrix printer measure up to a plotter? When this magazine reviewed JDL's 750c dot matrix printer in our plotter roundup last year (Volume 5 Number 18), we had some distinctly mixed reactions. Now JDL has introduced its new JDL-850 EWS, a heavy-duty printer that is even more clearly positioned as a plotter alternative. Even the model designation conveys this message: the JDL-850 EWS is called an "engineering workstation printer-plotter."

The 750c model we evaluated last year included an optional

external processor that added the industry-standard Hewlett-Packard Graphics Language (HPGL) to the printer's bag of tricks. The external processor used either 1.5 or 3 megabytes of RAM to store the incoming plotting instructions. While the external processor was elegant and worked well, it was also distinctly expensive and slightly clumsy.

The new JDL-850 EWS can use the external processor, too, but our test unit was equipped with an internal HPGL processor and a 1-megabyte buffer that accomplished the same function, accurately emulating an HP 7475 plotter. The 1-megabyte buffer on the new unit actually accomplishes the same func-

tions as last year's 3-megabyte buffer, as a result of improved algorithms.

The JDL-850 is a powerful 24-pin unit even when considered solely as a printer, rated at 360 characters per second in draft mode and 144 cps in near letter quality. It can produce up to 14 colors if you install a 4-color ribbon instead of the all-black one. Five attractive fonts are standard, including one with the IBM high-order character set. Two slots are provided for plug-in font cartridges, and the JDL-850 can download soft fonts as well.

The JDL-850 is capable of emulating the text and graphics modes of the Diablo 630 API, Fujitsu DPL24, Epson, and

PC FILE

JDL-850 EWS

JDL Inc.
2801 Townsgate Rd.
Westlake Village, CA 91361
(805) 495-3451

List Price: \$2,495; with optional HPGL compatibility, \$3,495; individual ROM cartridges, \$39 to \$95.

Requires: Parallel or serial port; HPGL option requires serial port.

In Short: A high-quality 24-pin printer that also emulates an HP plotter for fast, attractive color plots.

CIRCLE 422 ON READER SERVICE CARD

IBM 5182 color printers.

You can choose emulations and control other aspects of the (continues on page 38)

LaserPlotter Emulates HP 7470A Plotters on Laserjet Printers

PC HANDS ON

BY MARVIN BRYAN

If you have a Hewlett-Packard Laserjet or compatible printer, you can now plot graphs intended for a Hewlett-Packard two-pen plotter on your printer instead. The program that accomplishes this is *LaserPlotter*, manufactured by Insight Development Corp. and sold through Hewlett-Packard Co.

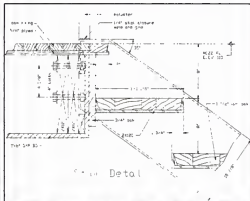
Select the HP 7470A plotter as the output device from within your graphics software; *LaserPlotter* then converts the plotting commands issued in HPGL, the Hewlett-Packard graphics language, into printing commands for the laser.

There are other strong advantages to this program. You can produce multiple copies of a graph at normal laser printing speed, with finer lines than those made by plotter pens and without the Woody Woodpecker

noise of a plotter. You can also create a white graph on a black background and batch-plot a series of graphs without operator intervention.

You can install *LaserPlotter* on a hard disk or run it from a

floppy disk drive. It can use the stored output directly from programs that can plot a graph to disk, such as *AutoCAD* and *CharMaster*. For programs like 1-2-3 that plot only to a port connecting a graphics device, a



For applications where technical renderings can be as small as 8 1/2 by 11 inches, *LaserPlotter* can provide plotter quality on an HP Laserjet.

PC FILE

LaserPlotter

Insight Development Corp.
1024 Country Club Dr.
Moraga, CA 94556
(415) 376-9451

List Price: \$150

Requires: HP Laserjet printer or compatible, DOS 2.0 or later.

In Short: An excellent utility that captures and prints HP plotter graphs to a laser printer and can do batch plots. Not copy protected.

CIRCLE 423 ON READER SERVICE CARD

separate RAM-resident utility, called *Capture*, is provided; it intercepts the commands intended for the plotter and writes them to disk ready for printing.

Remember that a Lotus .PIC file provides guidelines for plotting but is not in itself a plot file; thus the use of *Capture* is necessary with 1-2-3 and *Symphony*.

With a simple menu-driven structure and a reasonable price of \$150, *LaserPlotter* can be a cheap way to improve your graphics output.

New Version 3.0 with ■ New Network Commands ■ NETBIOS Support

If you own two or more PCs then you need *EasyLAN™* version 3.0.

THE *EASYLAN* OFFICE NETWORK

EasyLAN shares printers and disk drives between IBM PCs. *EasyLAN* can save you \$1,000 or more per PC by eliminating duplicate equipment purchases.

And now, you can run NETBIOS supported applications. Or you can write your own network applications for *EasyLAN* and other NETBIOS compatible networks.

EASYLAN VERSION 3.0 HIGHLIGHTS

- *EasyLAN* shares printers, plotters, data, and disk storage
- Supports up to 18 PCs or compatibles
- New Network Commands
- New NETBIOS
- PC to PC file transfer
- Print spooling
- PBX support
- Easy to install
- Easy to operate
- Modem support
- Performs in the background

EasyLAN's low price matches the small business user's cost-sensitive budget. It is the office network solution for less than \$100 per PC.

EasyLAN performs its operations concurrently in the background. *EasyLAN* communications, file transfers and printer operations all take place while each PC simultaneously performs such normal DOS applications as Lotus 1-2-3, Wordstar, and dBASE.

NEW NETBIOS SUPPORT—WRITE YOUR OWN COMMUNICATIONS PROGRAMS

Programmers may use *EasyLAN* to develop network applications using NETBIOS (interrupt 5c). These applications can now be operated across the low cost RS-232 communications links used by *EasyLAN*. Our new *EasyLAN* program is an example of a network application that uses NETBIOS for program to program communications.

Multi-user data base management applications that require a high overhead network operating system will perform faster on high cost networks operating at megabit speeds.

NEW VERSION 3.0 COMMANDS EXPAND NETWORK FLEXIBILITY

EZCLOCK lets PC's attached to the network read the time and date from a single master clock on the central PC, eliminating the need to install individual clock boards in each PC and ensuring that all file entries and updates made across the network are dated.

The EZ Make Directory and EZ Remove Directory commands function identically to the DOS Mkdir and Rmdir commands, and give remote users increased flexibility when it comes to managing subdirectories on the central PC.

EZBEEP lets you send an audible signal across the network, alerting a PC user that a file or message is being sent.

EasyLAN PBX SUPPORT BRINGS NEW FLEXIBILITY TO PC CONNECTIVITY

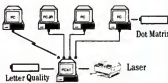
With *EasyLAN*'s PBX support, users can share peripheral and transfer files using PBX switched circuit connections and existing twisted pair wiring. *EasyLAN* has already been installed on a number of different PBX's, and recently was installed by Northern Telecom for use on its Meridian SL L.

EasyLAN—Networking With Netbios Support. And it's Only \$99.95 Per PC.

The value is high  —InfoWorld Report Card

Disk sharing uses *EasyLAN*'s EZCOPY command to move files to and from PC's. ASCII or binary files can be transferred in the foreground, or in the background while other DOS programs run.

Printer sharing operates transparently with existing programs. Print files are automatically spooled to disk and scheduled for printing. Multiple printers on the central PC may be designated for individual printing tasks.



EasyLAN Office Network

EASYLAN SPECIFICATIONS

Each PC in the network requires an individual licensed copy of the *EasyLAN* program and takes 20k of memory on each satellite PC, a serial port, and DOS 2.0 or above. *EasyLAN* runs on all IBM PC models and compatibles. The central PC requires a serial port for each satellite PC. The COM2 and COM6 boards are serial port expansion boards which permit you to add serial ports to the central PC.

EASY TO INSTALL

EasyLAN can be installed in less time than it takes to enjoy your coffee break. Just plug the *EasyLAN* cables into existing serial ports. The *EasyLAN* Network Configuration Program provides menu driven installation program that will guide you step-by-step through the software installation process.

EasyCALENDAR—USE YOUR NETWORK TO SCHEDULE MEETINGS.

The first of a new series of *Easy* network application products using NETBIOS is now available. *EasyCALENDAR* handles time management applications for individuals or a department and can be run on personal computers attached to any NETBIOS-compatible network.

Highlights:

CALENDAR MANAGEMENT for individuals and the work group

TASK MANAGEMENT to create, maintain and review to do lists

TODAY'S NEWS for broadcasting messages, notices of announcements across the network

MENU INTERFACE for easy set up and use

EasyCALENDAR's Data base for appointments, to do lists and news resides on the central PC. Satellite PCs attached through *EasyLAN* version 3.0 send network transactions to the central data base to invoke *EasyCALENDAR* functions.

The *EasyCALENDAR* calendaring program requires *EasyLAN* version 3.0 and is priced separately.

EasyCALENDAR will be available March 1987. Advance orders are being accepted now.

"I bought access to a laser jet printer for less than \$100."

—CONOCO Oil User

EasyLAN

ORDER TODAY 1-800-835-1515 in CA 408/738-8377



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Call 408/738-8377

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Tel: 02/640 88 24 Telex: 82 863 Telex: 02/660 8868

Server Technology, Inc., 140 Kifer Ct.

Sunnyvale, CA 94088, Telex 5106003481

Item	Description	Price	Qty	Amount
EL 08	<i>EasyLAN</i> Kit—for 2 PCs 30' cable, two disks & manuals	\$219.95	—	\$ —
EL 09	<i>EasyLAN</i> Expansion Kit—for 1-PC 30' cable, one disk & manual	\$119.95	—	\$ —
EL 10	<i>EasyLAN</i> disk & manual (30' disk \$109.95)	\$ 99.95	—	\$ —
EL 12	<i>EasyLAN</i> 30' cable	\$ 49.95	—	\$ —
EL 13	COM2 serial port expansion board, two ports	\$219.95	—	\$ —
EL 14	COM6 serial port expansion board, six ports	\$489.95	—	\$ —
EC 01	<i>EasyCALENDAR</i> Kit Supports 6-PC's and 10 people	\$199.95	—	\$ —
EL 15	Custom length cables, call for quote			
	Cr. res. add applicable sales tax	\$ —		\$ —
	Shipping charge USA \$10.00, other \$20.00			\$ —
				TOTAL ORDER \$ —

Handscan

(continued from page 33)

applications and invoke them as needed. The Handscan has four cursor-movement keys and a read key; the read key doubles as a control key in combination with the four arrow keys for a total of eight macros.

The scanner software is memory resident, but in most cases you invoke it only to change settings or load stored settings. Scanned input from the mouse is always available as an alternative to the keyboard. The mouse is a bit larger and heavier than most, but it's surprisingly easy to handle. You line up the text with the scanning head, hold down the read key, and roll



Handscan, a mouse look-alike, is a hand-held OCR that allows you to select the text you want to scan and then inputs it into an application.

the mouse to the right. After a little practice I could scan quickly and accurately.

Saba's documentation includes a useful tutorial that guides the new user through various features (there is even a gatefold spreadsheet sample) while updating the driver file. By the end of the tutorial you have built character substitutions and keyboard macros that can scan data into a 1-2-3 spreadsheet (the Handscan works with other spreadsheets as well). I tried a few of my own ideas and soon had it scanning a phone list into a *Perfect File* database.

I can image a number of uses for the Handscan, including converting data from a spreadsheet format (for example, a mainframe application) into data for PC applications. The Handscan combines good hardware design with a thoughtful approach to software. The result is a practical and economic alternative to traditional OCR

PC FACT FILE

Handscan

Saba Technologies
9300 SW Gemini Dr.
Beaverton, OR 97005
(800) 654-5274
List Price: \$649.95

Requires: 640K RAM, full-length slot, DOS 2.0 or later.
In Short: A well-designed, innovative use of scanning technology combined with memory-resident software. The hand-held scanner can read a wide variety of typewritten and letter quality text and the software enables you to put it directly into many applications.

CIRCLE 481 ON READER SERVICE CARD

The Handscan combines good hardware design with a thoughtful approach to software. The result is a practical alternative to traditional page scanners.

JDL-850 EWS

(continued from page 36)

printer's configuration either from the front panel, which features a four-character LCD display, several status annunciators, and six buttons, or via software commands. The HPGL emulation itself is also controlled via the front panel.

You can assign up to 14 colors to the JDL-850's simulated pens or simulate extra drawing, comparable to an HP 7475's .3- and .7-millimeter pens.

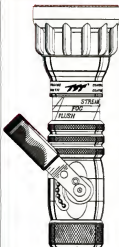
Unlike an HP 7475, which can plot only up to an 11- by 17-inch image, the JDL-850 can plot up to a C-size drawing (18 by 24 inches). You can reduce or enlarge the output over a 5 percent to 200 percent range in 5 percent increments, so you can draw C-size images even if your software sends instructions for a smaller plot.

Benchmark test results were impressive. The JDL-850 drew a B-size nozzle in 4.57 minutes, a one-color B-size shuttle in only 2.45, and a four-color in

3.75. These times are within seconds of the very fastest plotters we tested and are two to three times faster than some of the plotters.

The JDL-850 prints in 180- by 180-dot-per-inch resolution, which is significantly fewer steps per inch than a plotter. The difference is clearly visible in diagonal lines, but overall the plots we created with the JDL printer were quite acceptable for many purposes.

This year's JDL plotter/printer is a notable advance



JDL's 24-pin printer can accurately emulate an HP 7475 plotter; while it costs more than a C-size plotter, it doubles as a dot-matrix printer.

Designed for Engineers, JDL-850 EWS Is the Ultimate Spreadsheet Printer

If you ever manage to sneak the JDL-850 EWS out of the graphics department, you'll have your hands on a great spreadsheet machine. At 360 characters per second in draft mode, you can print models at a good clip, and when you need neater output, the 144-cps letter quality is very crisp.

Whatever font you use,

you can print to the very edge of the paper if you need to. Thus, if your spreadsheet is just a few characters wider than the usual 80-character limit for 8½-inch paper, you can squeeze in another 9 or 10 characters.

In compressed mode, you can put 145 characters on a line, which, at 9 characters per spreadsheet column,

lets you print a model out to column P. If you want to go all out, use 18-inch paper with 17-pitch type and cram 307 characters onto each line. That lets you print a model out to column AH.

Finally, depending on the font cards you use with the JDL-850, you can print IBM graphics characters. If you've drawn neat borders around your spreadsheet, they'll look just as sharp on paper as they do on-screen.

—Jared Taylor

over the earlier model in both speed and value. While it's still not cheap, buying both a C-size plotter and a first-rate 24-pin color printer would probably cost more.



WordPerfect
Executive

Groomed for top management.

Finally there is a productivity software package that perfectly fits your executive management style. Carefully tailored to enhance executive productivity, WordPerfect Executive is easy-to-use business software that lives up to its name.

WordPerfect Executive skillfully weaves the elements of word processing, spreadsheet analysis, calendaring and information management into one compact package. It is specially designed for laptop PCs, with the entire program on one 3½" diskette, yet it covers the many business

computing needs of executive computer users.

Create a business plan. Manage your time. Organize your thoughts into memos or letters. Even generate an itinerary or travel report. WordPerfect Executive lets you do it all on your desktop PC, or take it with you for your laptop.

Get the productivity software tailored for top management: WordPerfect Executive. For more information, call or write WordPerfect Corp., 288 West Center St., Orem, Utah 84057, (801) 225-5000.



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The American Success Story:

\$755
Basic system



The **CLUB 286** is manufactured and serviced only in the U.S.A.
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CLUB AT Inc. is offering same day shipping,
integration of the most up-to-date Intel parts, and 48 hours burn-in.

Model	Features	Price
1800	8MHz Basic system with option A	\$1075
1800A	10MHz Basic system with option A	\$1125
1800B	10MHz Zero wait state basic system with option A	\$1395

Basic System Features:

- Pro™ keyboard/MAXI SWITCH™ keyboard
- 8/10 MHz CPU depends on model
- 10 MHz option available
- 1MB of inboard memory (with 512K standard)
- 8 I/O expansion slots
- 195 watt power supply, UL, TUV, 110V/220V switchable
- Fully compatible high speed AMI BIOS, (written in U.S.A.)
- Full documentation operation manual with binder
- Limited one year warranty
- Made in the U.S.A.

Option A: 1.2MB Floppy Drive WD HD/Floppy Controller

Dealers and Corporate inquiries are welcome

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CLUB AT INC. (415) 490-2201

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Once Again America returns:



"If imitation is the sincerest form of flattery, the CLUB AT pays the IBM AT a heartfelt compliment. The only failing of the (CLUB AT) is that it imitates the IBM too accurately; and you can't beat that."

Karl Koessel PC World
December 1986

Software Compatibility
Xenix, AutoCad, MSDOS,
PC DOS, Novell Network,
dBASE, Lotus, Sidekick,
Symphony and others...

CLUB 286 8MHz Mono System

\$1149

- Intel 80286-8 CPU
- 512K Standard, expandable to 1024K on Motherboard
- 8 Slots (2.88M, 6-16bit) • Combo 2FD/2HD Controller
- 195 watt power supply 110/220v (FCC/CSA/UL Approved)
- Clock Calendar with Battery Backup • 1.2MB Floppy Drive-IBM Grey
- AT™ Style MAXI SWITCH™ keyboard/Pro™ keyboard
- Hercules 132 Columns High-Res Graphics Card
- High Resolution 800 x 320 IBM Quality Monitor
- Parallel Printer Port • Plug-and-Play-Fully Installed
- AMI BIOS High Speed/Fully Compatible/Written in U.S.A.
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With 30MB Full HT 39ms **\$1749**

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\$1549

- Intel 80286-8 CPU
- 512K Standard, expandable to 1024K on Motherboard
- 8 Slots (2.88M, 6-16bit) • Combo 2FD/2HD Controller
- 195 watt power supply 110/220v (FCC/CSA/UL Approved)
- Clock Calendar with Battery Backup • 1.2MB Floppy Drive-IBM Grey
- AT™ Style MAXI SWITCH™ keyboard/Pro™ keyboard
- Everex Micro EGA 16 color graphics • CGA, MDA, Hercules compatible
- High Resolution IBM quality EGA, CGA Monitor 640 x 350
- Plug and Play-Fully Installed
- AMI BIOS High Speed/Fully Compatible/Written in U.S.A.
- 200 page documentation • Built in Set-up Software

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With 30MB Full HT 39ms **\$2149**

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\$1629

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- AMI BIOS High Speed/Fully Compatible
- 512K Standard, expandable to 1024K on Motherboard
- 8 Slots (0.1,2,3,4 Wait State Insertable)
- Combo 2FD/2HD Controller, WD chipset
- 195 watt power supply 110/220v (FCC/CSA/UL Approved)
- Clock Calendar with Battery Backup • 1.2MB Floppy Drive-IBM Grey
- AT™ Style MAXI SWITCH™ keyboard/Pro™ keyboard
- Hercules Graphics 132 Columns High-Res Graphics Card
- High Resolution IBM Quality Monitor
- 2 Serial ports (COM1-COM4) • 2 Parallel ports
- 200 page documentation

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With 80MB Full HT 23ms **\$2770**

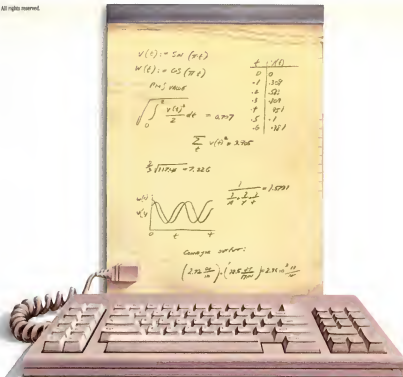
CLUB 286 10MHz Zero Wait State EGA System

\$2099

- Intel 80286-10 CPU, 8/10MHz Zero Wait State Keyboard Switchable
- AMI BIOS High Speed/Fully Compatible
- 512K Standard, expandable to 1024K on Motherboard
- 8 Slots (0.1,2,3,4 Wait State Insertable)
- Combo 2FD/2HD Controller, WD chipset
- 195 watt power supply 110/220v (FCC/CSA/UL Approved)
- Clock Calendar with Battery Backup • 1.2MB Floppy Drive-IBM Grey
- AT™ Style MAXI SWITCH™ keyboard/Pro™ keyboard
- Everex Micro EGA Card (MDA, CGA, EGA)
- High Resolution EGA Monitor (CGA, EGA) 640 x 350
- 2 Serial ports (COM1-COM4) • 1 Parallel port
- 200 page documentation

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MathCAD™ turns your PC into an electronic scratchpad.

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It's the first numeric software that works like a word processor. The first software of its kind that's not a programming language. Think of it as the first WYSIWYG calculator. For the first time ever, MathCAD lets you do calculations on your PC in real math notation, as simply as on a scratchpad.

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"It has a free form style that lets you just sit down in front of the PC and do the work you probably bought the computer for in the first place." *PC Magazine*

MathCAD is much faster and easier than doing calculations by hand or writing programs. And unlike a calculator, MathCAD lets you see and record every step. You can add text anywhere to support your work. And print or save your entire calculation as an integrated document that anyone can understand.

"It's hard to do justice to this software in any review. You feel like you've just discovered the power of a computer for the first time." *IEEE Software*

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(In Massachusetts: 617-577-1017)

MathCAD
MathSoft, Inc., 1 Kendall Sq., Cambridge, MA 02139



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IBM PC™ International Business Machines Corporation
MathCAD™ MathSoft, Inc.

CIRCLE 154 ON READER SERVICE CARD

New Proprietary Doesn't Mess Up a Good Thing

PC HANDS ON

BY JONATHAN MATZKIN

The Proprietary II proves that IBM knows a good thing when it has one. In updating the highly successful Proprietary, IBM has left well enough largely alone: the Proprietary II is basically the same hardworking product as its predecessor.

That's good news, when you consider what the Proprietary had going for it—good performance, solid construction, and a competitive price. Not to mention its genuine "born in the

USA" credentials. IBM has added a number of improvements and rechristened the machine Proprietary II.

First of all, the Proprietary II is significantly faster. We tested the original Proprietary at 91 characters per second in draft mode, while the Proprietary II buzzes along at 111 cps in draft mode. But the real story is Fastfont, a new elite font.

In Fastfont, the Proprietary II prints at 119 cps, for a total improvement in top speed over the original Proprietary of roughly 32 percent.

The Proprietary II's front



IBM's Proprietary II retains the original value of the Proprietary and adds some new features.

panel has switches for quiet mode, which noticeably attenuates noise at some cost in speed, and a button to activate the printer's new power-assisted paper-loading feature.

Unlike some other power load assists, this one begins by moving very slowly so the paper has a chance to seat itself. Then it quickly rolls the paper the rest of the way around until it is

positioned for printing.

Another nifty little improvement helps eliminate the aggravation of ripping your copy in half instead of along the perforations. Pressing down on the paper cover pins the paper down and allows easy tearing along the perforations.

At \$549, the Proprietary II is a good deal. At the inevitable discount, it looks all the more attractive. The Proprietary is what an update should be: it enhances the performance and features of the earlier model while offering some new and welcome wrinkles of its own.

List Price: IBM Proprietary II, \$549. Contact your local IBM dealer.

CIRCLE 432 ON READER SERVICE CARD

Newbury OSP-3 Chugs Steadily On, Stylishly

PC HANDS ON

BY JONATHAN MATZKIN

With its wedge-shaped body and streamlined acoustic hood, Newbury Data Office Systems Printer-3 looks more like a race car than a PC peripheral. Those futuristic looks promise equally high-tech performance. It's a promise that the printer lives up to on most counts.

The OSP-3's design is as ambitious as its appearance. Sporting a four-color ribbon and a full complement of dot matrix features, the printer has power to spare for almost any general office application.

Print quality is quite attractive, and the OSP-3 offers a choice of three near-letter-quality fonts.

Newbury Data is a leader among European peripheral makers; this printer displays the kind of solid construction you'd expect from a company with roots in the mainframe world.

The OSP-3's designers clearly had ease of use in mind when they were at the drawing board. All print and formatting features are accessible from a simple LED control panel. Paper advance is also totally electronic;

the OSP-3 doesn't even have a manual paper knob. Cassette sheet feeders are very easy to load. And switching to tractor-fed fanfold paper is a simple matter.

The OSP-3 prints at only 75 characters per second in draft mode—very slow for a unit in its price class. Also, its size and weight (about 40 pounds) put it at the outer edge of the desktop category.

Several important accessories—notably the sheet and tractor feeds—are options at additional cost. The smoked plastic acoustic hood is also optional. Most users will want it, though, both for its noise attenuating function and for its aesthetic value.

The OSP-3 is a highly competent printer. Despite a few drawbacks, it is definitely a versatile workhorse for office applications.

List Price: Newbury Data Office Systems Printer-3, \$1,560; with twin sheet feeders, \$1,690; tractor feed, \$1,430; stand, \$95; acoustic hood, \$95. Newbury Data Inc., 2200 Pacific Coast Highway, Hermosa Beach, CA 90254; (213) 372-3775.

CIRCLE 433 ON READER SERVICE CARD

IBM Proprietary II

Q.m

IBM Proprietary II: Font (12 cpi)... Emphasized trike mode... Correspondence NLQ font... Emphasized subscript print... Superscript

Type: Impact matrix (nine pins)
Carriage width: 8 1/4 inches
Price: \$549
SPEED (cps):
Draft: 111
Type pitches (cpi): 8, 6, 8.55, 10, 12, 17
SOUND LEVEL (decibels):
Draft: 60
Tested: 75 in draft mode, 70 in quiet mode

FEATURES:
Printing: Horizontal emphasis (bold), vertical emphasis (double strike), correspondence quality, underline, sub/superscript
Formatting: Proportional spacing, horizontal tab, vertical tab, variable form length
COMPATIBILITY:
IBM character set: Low and high
Graphics: Epson FX
Text: IBM Proprietary

Newbury Data Office Systems Printer-3

Q.M

OSP-3: Power On Default Double strike print. Emission print. NLQ font. Q2 (Gothic) font. Superscript underlined print. Condensed

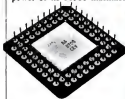
Type: Impact matrix (18 pins)
Carriage width: 13 inches
Price: \$1,560
SPEED (cps):
Draft: 75
Type pitches (cpi): 10, 12, 15, 17
SOUND LEVEL (decibels):
Draft: 55
Tested: 78 without acoustic hood, 72 with acoustic hood

FEATURES:
Printing: Horizontal emphasis (bold), vertical emphasis (double strike), correspondence quality, underline, sub/superscript, four-color ribbon
Formatting: Proportional spacing, horizontal tab, vertical tab
COMPATIBILITY:
IBM character set: Low and high
Graphics: Epson FX, Panasonic KX-P1001, IBM Proprietary
Text: Epson MX-80, IBM Proprietary

NEW ON THE MARKET ■ JONATHAN MATZKIN

Intel Finally Ships Its 80387 Coprocessor For 80386 Computers

One promise of 32-bit computing is massive number crunching at previously unheard-of speeds. So users have been eagerly awaiting the appearance of Intel's new 80387 math coprocessor, which will unlock the full numerical throughput power of its 80386 machines.



Intel's 80387 math coprocessor chip brings increased numerical throughput to the 32-bit 80386 environment.

Intel says that the \$795 80387 runs raw floating-point calculations roughly four to six times faster than the 80287 chip.

List Price: 80387 coprocessor, \$795. **Requires:** Socket designed to accept 80387 math coprocessor.

Intel Personal Computer Enhancement Operation, 5200 Elam Young Pkwy., Mail Stop TOD-07, Hillsboro, OR 97123; (800) 538-3373.

CIRCLE 429 ON READER SERVICE CARD

Pocketable Modem Is Small in Size, Price, But Has Many Features

The \$119 Parrot 1200 from Novation is about the size of an audiocassette, but it has the full range of features you would expect in an external modem. Fully compatible with the Hayes AT command set, the Parrot 1200 offers switchable data transmission rates of 300 or 1,200 bits per second.

It has four LED status indicators and a speaker with volume control for call monitoring. The auto-answer modem has both pulse and touch-tone dialing and has a built-in self-test routine.

The 3-ounce device gets its power from the host computer's RS-232 interface, so it requires no batteries or external AC power.

List Price: Parrot 1200, \$119.

Requires: Cable, communications software. **Novation Inc.,** 12345 Lassen St., Chatsworth, CA 91311; (818) 998-3060.

CIRCLE 440 ON READER SERVICE CARD

Add-in Card Has EGA, An 80286 Accelerator, And Clock/Calendar

PC Technologies has announced the 286 Rainbow Plus, a \$945 add-in card that combines an enhanced graphics adapter with a 10-MHz 80286 accelerator. A battery-backed-up clock/calendar is standard, and an optional daughterboard



Novation Inc.'s Parrot 1200 is compact, but offers many of the features found on larger external modems.

adds a parallel port and a Microsoft InPort mouse interface.

The single-slot card features a 16K-byte memory cache that works in conjunction with the accelerator, and the board has a socket for an optional 80287 math coprocessor. The memory cache can be disabled from the keyboard.

PC Technologies says that a 16-bit video BIOS increases graphics processing speed and provides full IBM EGA software compatibility. The 286 Rainbow Plus also emulates CGA, MDA, and Hercules video adapters.

List Price: 286 Rainbow Plus, \$945. **Daughterboard** with parallel port and mouse interface, \$50. **Requires:** IBM PC, PC-XT, or compatible. **PC Technologies Inc.,** 704 Airport Blvd., P.O. Box 2090, Ann Arbor, MI 48106; (800) 821-3086.

CIRCLE 443 ON READER SERVICE CARD

HOT PROSPECT

Princeton Announces First Monitor to Accommodate Old, New PC Standard

The change to analog monitors with a new hardware connection was one of the bombshells that IBM dropped with the announcement of the Personal System/2 family. But the ever-adaptable microcomputer market has already produced a compatible third-party monitor. Princeton Graphic Systems has announced the \$795 Ultrasync color monitor, which, the company says, is compatible with both the new PS/2 standard and existing PCs, as well as with Apple's new Mac II and MacSE microcomputers. The Ultrasync will be sold with an adapter to plug into PS/2 machines; a separate adapter will be needed to plug into PCs and other computers.

The 12-inch, high-resolution monitor is EGA,

CGA, PGC, and monochrome compatible and automatically adjusts to the scanning rate of different graphics boards. It has a horizontal scanning frequency of 15 through 35 kHz and a vertical scanning frequency of 50 through 120 Hz. Maximum resolution is 770 by 570 pixels, and the Ultrasync features a .28-millimeter dot pitch.

The Ultrasync comes with a built-in tilt-and-swivel base.

List Price: Ultrasync, \$795. **Princeton Graphic Systems,** 601 Ewing St., Bldg. A, Princeton, NJ 08540; (609) 683-1661.

CIRCLE 438 ON READER SERVICE CARD

The \$795 Ultrasync monitor from Princeton Graphic Systems is compatible with a wide variety of old and new graphics standards, and it interfaces with IBM's PS/2 series.

**Editor's Toolkit Adds Writer's Aids to Word Processing Packages**

BestInfo, maker of the popular Superpage publishing software, has introduced *The Editor's Toolkit*, a collection of memory-resident programs that aid in writing and editing.

In addition to a spelling checker and thesaurus, the \$250 package includes a usage alert feature that flags 1,600 commonly misused words.

A compare facility allows you to compare two existing files and embed notes in one of them to report differences.

A readability checking feature compiles statistics on the average number of words per sentence, the average number of

syllables per word, and other readability characteristics.

The Editor's Toolkit is designed for use with XyQuest's XyWrite III word processor, but Bestinfo says that the package will run with other major word processors.

List Price: *The Editor's Toolkit*, \$250. **Requires:** Compatible word processor. Not copy protected. Bestinfo Inc., 1400 N. Providence Rd., #117, Mesa, PA 19063; (215) 891-6500.

CIRCLE 441 ON READER SERVICE CARD

\$595 A-Sized Digitizer Works with CAD, Other Graphics Applications

CalComp has introduced a new low-priced digitizer that is compatible with popular CAD packages such as Autodesk's AutoCAD and with graphics packages such as Lotus's *FreeLance*.

The \$595 DrawingBoard is an A-sized digitizer that has an active digitizing area of 12 by 12 inches and selectable resolution up to 1,016 lines per inch. The digitizer is aimed at CAD applications, according to CalComp, in addition to desktop publishing or other uses that may require menu selection or actual sketching of artwork.

List Price: DrawingBoard, with pen stylus, \$595. **Requires:** Serial port. CalComp, 2411 W. La Palma Ave., Anaheim, CA 92801; (800) CALCOMP.

CIRCLE 434 ON READER SERVICE CARD

Manzana's Add-on 3 1/2-Inch Microfloppy Drives Feature 1.44-Megabyte Capacity

Small disks with big capacity may be in your PC's future. Manzana Microsystems has introduced three new 3 1/2-inch replacement floppy disk drives with formatted storage capacity of 1.44 megabytes.

The \$325 3Five Drive Plus internal system fits in a standard half-height drive bay and is connected to the floppy disk controller with the existing cable.

Two external units connect to the host 80286 or 80386 PC through Manzana's MUX adapter card, which itself installs in a slot. The card allows connection of the external floppy without loss of existing internal floppies. The external drives cost \$475 for a host-powered system and \$595 for a self-powered version.

The disk drives come with Manzana's 3Five software, which allows the disk drives to access the higher-capacity 3 1/2-

inch storage formats, using DOS 2.0 or later.

Manzana is also bundling Design Software's *Backup Plus*, a hard disk backup package, with the disk drives.

Manzana says that the new 1.44-megabyte disk drives are both upwardly and downwardly compatible with existing disk formats. They can

read, write, and format for 1.2 megabytes, 720K bytes, 360K bytes, and 180K bytes, in addition to 1.44 megabytes.

List Price: 3Five Drive Plus, internal version, \$325; external, host-powered version, \$475; external, self-powered version, \$595. **Requires:** 80286- or 80386-based PC, DOS 2.0 or later. Manzana Microsystems, 7334 Hollister Ave., Suite B, Goleta, CA 93118; (805) 968-1387.

CIRCLE 435 ON READER SERVICE CARD



High-capacity 3 1/2-inch drives from Manzana (\$325 for internal drive) can format floppy disks for 1.44 megabytes of data.

Hardware Has Remote Phone Access to PCs, Line Surge Suppression

Imagineering has introduced a

telephone-accessible device that can power-up remote PCs. The \$280 Modem Power senses incoming telephone rings and then turns on the power to the PC. When all communications

cease, the device shuts off the power to the remotely accessed PC, after allowing enough time for the computer to close all files. Both the modem and computer circuits have line surge suppression.

List Price: Modem Power, \$280. **Requires:** Hayes-compatible modem. Imagineering Inc., P.O. Box 601, Melville, NY 11747; (516) 549-4558.

CIRCLE 436 ON READER SERVICE CARD



Modem Power is a device that allows remote power-up of PCs through a phone line.

Thomson Unveils Color Graphics Adapters That Use Texas Instruments Coprocessor

Thomson Consumer Products Corp. has announced three graphics adapters that combine high performance with competitive pricing. The Thomson Enhanced Graphics Adapter is compatible with the IBM EGA standard, Thomson says, and offers resolution of up to 640 by 350 pixels for color or monochrome graphics. Text resolution is as high as 720 by 350.

The "Ultra" version of the EGA provides 640 by 480 reso-

lution with 16 simultaneous colors. It emulates the EGA on IBM monochrome displays with 16 shades of gray, and it emulates the CGA with four levels of gray.

Thomson claims that the Ultra EGA provides the most powerful implementation of *Microsoft Windows* that is available on an EGA. Among the hardware features are a cursor up to 32 by 64 pixels in size and the ability to read, modify, or write

to video memory.

The Advanced Graphics Controller uses the Texas Instruments 32-bit 34010 graphics chip, which offloads most graphics functions from the PC's processor. Thomson says the performance of the chip is enhanced by the addition of a 256K-byte cache memory and 32 internal registers. The Advanced Graphics Controller has an automatic-switching 8/16-bit bus to ensure compatibility with PCs and XT's as well as 80286-based machines. EGA compatibility is available through a pig-

gyback hardware option.

The controller offers resolution of 640 by 480 with 64 colors displayed simultaneously. Monochrome resolution is 1,024 by 768.

List Price: Enhanced Graphics Adapter, \$295; Ultra EGA, \$495; Advanced Graphics Controller, \$1,195. Optional EGA module for AGC, \$250. Thomson Consumer Products Corp., 5731 W. Slauson Ave., #111, Culver City, CA 90230; (213) 568-1002, (800) 325-0464.

CIRCLE 437 ON READER SERVICE CARD

Actor Gives Microsoft Windows Programmers a Third Choice

PC HANDS ON

BY J. H. SMITH

Until now, if you wanted to write a *Microsoft Windows* application, you used C or assembler. There's now a third choice. The Whitewater Group's Actor lets you develop *Windows* programs interactively from within *Windows* (also see "Windows Shopping: Applications for the Environment," page 271).

Actor is an "object-oriented" language very much like the Smalltalk language (see *PC Magazine*, First Looks, page 53, Volume 5 Number 19) but with a Pascal-like syntax. Object-oriented languages are a natural for *Windows*' message-passing implementation, and make it easier for a programmer to build on existing code.

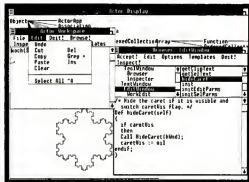
With Actor comes a wealth of classes to build on. You'll find *Windows* objects (menus,

buttons, lists, rectangles, polygons, ellipses); the *Smalltalk/V* pantheon of collections (arrays, sets, and more); even support for lexical analysis and parser-generator tables if you want to write a compiler.

The Actor development en-

vironment uses mostly pop-up windows. Programmers can easily browse and modify Actor source code.

Two debuggers are included. So are tools to profile your programs' speed and trim an application down to size.



Actor, an object-oriented language with a Pascal-like syntax, is ideal for developing *Windows* applications.

HC40 Hard Disk: One of the Fastest

PC HANDS ON

BY WINN L. ROSCH

The fastest hard disk that you can attach to your AT—that's the claim Core International makes for its new HC40 drive. The figures look amazing—an average access time of 8 milliseconds on Core's benchmark tests, compared to 40 or so for a stock AT hard disk.

While those numbers do reveal some clever engineering, they are misleading. Rather than speeding up the HC40 to make your data processing go faster, Core has merely boosted the disk's performance on activities tested by common benchmark tests.

The most common yardstick for measuring disk speed is called average access time. In theory, this figure should indi-

cate how quickly the disk drive can find any random byte written on the disk.

Core uses clever software to make test programs think that the HC40 disk is arranged differently from its physical layout—the drive acts like it has been cut in half and stacked on top of itself. The number of tracks is cut in half and the headcount doubled. As a result, the tested average access times are cut just about in half. Unfortunately, this trick does nothing for the actual performance of the drive.

All that said, the Core HC40 is probably the quickest 40 megabyte of formatted disk storage you can add to your AT. Based on a fast-access Control Data hard disk and a Scientific Micro Systems 8600-series controller, the system uses the new ESDI (enhanced small disk in-

terface) system, which transfers data to and from the disk at 10 MHz, double the speed of the ST506 interface used by IBM's hard disk and controller.

The voice coil actuator in the Control Data drive is about twice as fast as the stock AT hard disk.

The SMS controller replaces the stock controller in your AT and takes command of your floppy disk drives as well as the Core disk. (The 16-bit bus full-length board is low enough to fit into the XT Model 286 as well as the AT.)

It keeps up with the fastest drives you can connect to your AT—which, incidentally, include the Core HC150 and the Emerald DOS 150-3000, both 150 megabyte units based on Control Data drives and SMS controllers using the ESDI interface.

PC FACT FILE

Actor

The Whitewater Group Inc.
Technology Innovation Center
906 University Pl.
Evanston, IL 60201
(312) 491-2370

List Price: \$495

Requires: 640K RAM, hard disk, Microsoft mouse or other *Windows*-compatible pointing device, *Windows*-compatible graphics display and adapter, DOS 2.0 or later.

In Short: An interactive programming environment for developing *Windows* applications. You can write *Windows* programs much faster with Actor than with C or assembly language. Not copy protected.

CIRCLE 404 ON READER SERVICE CARD

For *Windows* applications programmers, the choice should be clear. If execution speed is critical, use C or even assembler. But if you've got to write it fast, Actor will save you a lot of sweat, pain, and time.

PC FACT FILE

Core HC40

Core International
7171 N. Federal Hwy.
Boca Raton, FL 33431
(305) 997-6055

List Price: Core HC40 drive only, \$995; ESDI controller, \$595 with floppy controller; \$545 without floppy controller.

Requires: AT or compatible, DOS 3.0 or later.

In Short: A 40-megabyte, high-speed hard disk system that uses a 10-MHz ESDI interface and one-to-one sector interleaving.

CIRCLE 401 ON READER SERVICE CARD

You should choose the Core HC40 if you need really quick data access, but do not base your decision solely on test results.

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R:base Graphics Strikes a Slick Balance Between Ease, Power

PC HANDS ON

BY MITT JONES

You can start kicking yourself now if you use an *R:base* database but didn't hold out for Microrim's graphics offering before buying a charting program: *R:base Graphics* has arrived. A few limitations aside, the new member of the *R:base* family is a welcome addition.

Rather than force you to choose a graph type before you specify data, the menu system first guides you through the creation of a line graph. You begin by specifying a data source—either an *R:base* database or ASCII data file. A full-screen editor helps you create a file if need be. Then you choose the fields you want graphed, choose a sorting order, and set conditions for any of the fields. *R:base Graphics* displays a line graph with labels and a legend.

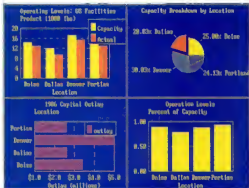
If you've ever toiled at the keyboard for hours getting your data just right for a graph, you'll appreciate the *R:base Graphics*

data reduction features. You can sort and group fields, make use of conditional operators to weed out unwanted values, and create new variables for graphing, all without leaving *R:base Graphics*. Standard mathematical operators and over 50 predefined functions let you define variables to suit your needs.

R:base Graphics boasts an

impressive array of annotation features. You can enter text anywhere on a graph, edit labels, and move the legend.

The big disappointment is *R:base's* color support. Though it supports EGA resolution, *R:base* does not support full EGA color. The result? *R:base* offers only 14 colors, of which you can display only 4 at a time.



Although *R:base Graphics* gives you some control over color selection, you are limited to four choices among the foreground colors.

PC FACT FILE

R:base Graphics

Microrim
P.O. Box 97022
3925 159th Ave. NE
Redmond, WA 98073-9722
(206) 885-2000
List Price: \$295

Requires: 512K RAM, hard disk.

In Short: A powerful, easy-to-master business graphics package geared toward *R:base* database users.

CIRCLE 428 ON READER SERVICE CARD

I wasn't even very pleased with the color combinations available out of those 14; you choose from 7 possible background colors and four combinations of 3 foreground colors. I found only two color combinations I liked.

Microrim designed *R:base Graphics* for use with *R:base 4000*, *5000*, and *System V*, so the package supports only *R:base* database files and ASCII import/export. In keeping with the Microrim tradition, it strikes a nice balance between ease of use and flexibility.

ZyIndex 2.2: A Word Cruncher's Dream

PC HANDS ON

BY M. DAVID STONE

One problem all PC users face is keeping track of their files. Whether you use floppy disks, a hard disk, or removable cartridges, the problem only gets harder as your collection of data gets larger.

Enter ZyLab Corp.'s *ZyIndex*, an indexing and retrieval program. Give *ZyIndex* the name of the file and it will find it, display the contents, and tell you where it is. Give it a search word or phrase and it will find all files that include the phrase. *ZyIndex* has been helping to find

lost files for years, but the latest version does the job even faster.

Using *ZyIndex* is a two-step process. First you index the files, then find and retrieve matches. You can add new files to the index, and you can reindex files that you've changed.

ZyIndex has a reputation for speed, but ZyLab Corp. claims that Version 2.2 is faster. In my tests, a search for "printer" took 4.8 seconds with 1.5 megabytes of files indexed. More-complicated phrases or the use of wildcards can increase the time substantially. With "printer" as the keyword, the time jumped to 11.1 seconds.

Unfortunately, *ZyIndex's* in-

dexing process is far more time-consuming, taking roughly 2 minutes per 100K bytes. This means you will want to index only your archived files.

ZyIndex will search files written in ASCII or with any of these word processors: *WordPerfect*, *WordStar*, *MultiMate*, *Microsoft Word*, *Volkswriter Deluxe II*, *PFS:Write*, *Smart Word Processor*, *OfficeWriter*, *Spellbinder*, and *DisplayWrite 2* and 3.

At \$695 for the Plus version of *ZyIndex*, the program is clearly aimed at serious word crunchers who need the capacity to index 15,000 files. But there is also a Professional version (indexes 5,000 files) and a Standard version (indexes 500 files). If your collection of text files is large enough, the question is not whether you can afford *ZyIndex*, but whether you can afford to be without it.

PC FACT FILE

ZyIndex, Version 2.2

ZyLab Corp.
233 E. Erie St.
Chicago, IL 60611
(800) 544-6339
(312) 642-2201 (in Ill.)
List Price: Standard version, \$145; Professional, \$295; Plus, \$695.

Requires: 256K RAM, two disk drives, DOS 2.0 or later.
In Short: This indexing and retrieval program offers fast retrieval of text files once they've been indexed. It will let you find your archived files with minimum fuss, and it will let you cut and paste information from multiple files into a single working file. Not copy protected.

CIRCLE 429 ON READER SERVICE CARD

Introducing
a new personal computer
that does something
no other portable this small
can do.

Everything.



It simply works better

COMPAQ
PORTABLE III

The new COMPAQ PORTABLE III™ represents the most power and performance ever to fit in a package this small. What makes it remarkable is that we sacrificed nothing to accomplish this feat. It's the world's smallest full-function personal computer with *all* the advanced capabilities you'd expect to find in a high-performance desktop computer.

At 18 pounds, and half the size of our original portable, it is clearly the ultimate in portable computing today.

It features advanced 12-MHz 80286 technology that enables you to run programs written for 8-MHz personal computers up to 50% faster without sacrificing compatibility. And it offers enough RAM to satisfy even the

most demanding users. It comes with 640 Kbytes standard and is expandable to 6.6 Megabytes without touching one of its two attachable full-size expansion slots. Plus it offers an optional 20- or 40-Megabyte high-speed internal fixed disk drive. So now you don't have to resort to external add-on drives that make portability difficult.

It feels like we left new COMPAQ

We didn't.



12-MHz 80286
microprocessor



Full-size, detachable,



Uses industry-standard 5 1/4" diskettes

We didn't stop there. Notice the full-size standard keyboard with a numeric keypad. The industry-standard 5¼-inch diskette drive compatible with the rest of the business world. The full-size, adjustable 640 × 400 high-resolution plasma display, which conveniently provides text and graphics on one screen. Even an optional internal modem.

With the COMPAQ PORTABLE III, there are simply no trade-offs. Using ingenious methods to streamline the technology, like surface-mounting chips on boards, we combined full-functionality with enhanced portability. Which reaffirms the status of Compaq® as the world leader in portable personal computers.



something out of the PORTABLE III.



It simply works better

COMPAQ
PORTABLE III

No other portable computer harnesses as much power, speed, readability, memory, storage, and built-in industry-standard features as the new COMPAQ PORTABLE III.

Most other portables and laptops use much slower micro-processors. Most don't offer high-resolution displays or expansion slots. Many don't offer

high-capacity fixed disk drives. And not one offers the rugged, patented shock-mounting technology that's so important for the survival of a portable computer.

Their diskette drives are usually 3½" drives which make it impossible to use industry-standard 5¼" diskettes. Compaq, on the other hand,

uses industry-standard fixed disk drives. And our drives maximize compatibility with your desktop personal computers, so you don't have to transfer your data. Plus, our detachable full-size keyboard doesn't force you to use one that's small and cramped.

Not one of our competitors can rival our memory and stor-

It feels like the others
They did.

age capacity. The most RAM others offer is 2.6 Megabytes, which looks very small next to our 6.6 Megabytes. Storage is another story. The internal storage capacity of all our major competitors put together can't equal the storage capacity of a single COMPAQ PORTABLE III. We even offer an attachable, portable expansion unit, with

two full-size industry-standard slots so you can add features of your own.

It stands to reason that if our competitors had included *some* of the features we offer, chances are they would no longer be portables. This might be why Compaq sells more portable computers than any other company in the world.



left something out.



It simply works better

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PORTABLE III

The new COMPAQ PORTABLE III is actually half the size of our first portable. It's also the fastest portable computer in the world today.

With a processing speed of 12 MHz, its 80286 microprocessor is noticeably superior to most advanced-technology desktops. But processing speed, as most serious

business users know, is only one facet of high performance.

The greatest limiting factor of total system performance is the speed of disk drives. The fixed disk drives in the COMPAQ PORTABLE III are three times faster than most others, with an average access time of less than

30 milliseconds. We also built in high-speed RAM. Together, these enhancements work with the high-speed processor to avoid system bottlenecks, thereby maximizing information flow. You can even add an 8-MHz 80287 coprocessor to accelerate math-intensive work. So now there's

We run even faster since



less wait, with less weight.

The COMPAQ PORTABLE III is the most advanced portable in the world and offers the sophisticated user features normally associated with desktops. As with any computer we design, we make your needs our blueprint. Compaq gives you more function-

ality, versatility, power, memory, storage, and performance to go.

Through innovative design and engineering, we've built even more into an even smaller package. So once again, Compaq has set a precedent, a standard by which all other portable computers will be judged.



we've lost a few pounds.



It simply works better

COMPAQ
PORTABLE III

We obviously designed the COMPAQ PORTABLE III for the open road. But what makes it exceptional is that it can also hold its own on a desktop. Its speed, memory, and storage capacity help it outperform most desktop PC's. As an executive power tool, it can handle your biggest spreadsheets and largest data bases. And its ability to network and communicate with

mainframes will also surprise you.

So perhaps it's *not* surprising that the COMPAQ PORTABLE III, like all of our portables, isn't just for people who are going places. It's also for those who appreciate a footprint that's nearly 50% smaller than the average desktop computer. This built-in versatility proves Compaq always has a better handle on personal computing.

See the new COMPAQ PORTABLE III on a desktop near you—at one of over 3000 Authorized COMPAQ Computer Dealers worldwide.

For more information or the dealer nearest you, call 1-800-231-0900 and ask for Operator 31. In Canada, call 416-449-8741, Operator 31.

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This COMPAQ PORTABLE III
is so busy in the office,
it doesn't get out much.



It simply works better

COMPAQ
PORTABLE III

WRRROOOM.



INTRODUCING FAST FORWARD™ NOW ANY SOFTWARE CAN RUN UP TO 10 TIMES FASTER.

No more doodling while your database goes digging. Or lollygagging while your spreadsheet loads. Or taking five while your word processing program takes forever.

With Fast Forward, any software runs 2 to 10 times faster.

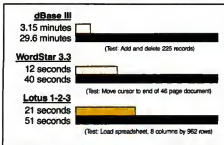
CAN SOFTWARE REALLY DO THAT TO SOFTWARE?

Fast Forward can. Normally, your computer is constantly going to your disk and wading through massive amounts of data.

But with Fast Forward, data is retained in your computer's internal memory. Which is incredibly fast. Much faster than hard disks. Hundreds of times faster than floppies.

FAST FORWARD PERFORMANCE

☐ With Fast Forward ☒ Without Fast Forward



All tests done on 640K IBM PC, 20 megabyte hard disk and floppy drive. 320K RAM allocated to Fast Forward.

THE MORE YOU USE IT, THE FASTER YOU GO.

Once installed, Fast Forward works invisibly. As you use data, it's automatically stored in your computer's memory—and instantly available the next time you need it. Programs requiring frequent disk access (like dBase III) will show amazing improvements. And adding extended memory gives Fast Forward more room to work. So software runs even faster.

PERFORMANCE HAS A NEW PRICE: \$69.95.

You can buy a faster computer. Or an expensive accelerator board. But if you're ready to turn on the speed without turning over a bundle of money, ask for Fast Forward. It's from the Mark Williams Company, makers of quality software tools since 1976. And it's available at your software dealer. In the software department of your favorite bookstore. Or by calling 1-800-MWC-1700.*

And hurry: Because

it'll be going fast.

*In Illinois: (312) 472-6659



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Chicago, Illinois 60614

Fast Forward runs on IBM PCs and 200% compatibles. Not copy protected.
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MONEY-BACK
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BEWARE OF THE AT MEMORY GREMLINS.



See us at booth #406

COMDEX/Spring '87

June 1-4, 1987

Georgia World Congress Center
Atlanta, GA

ONLY ECCELL— THE ECC-PROTECTED MEMORY CARD— CAN KEEP YOU FROM BECOMING THEIR NEXT VICTIM.

If you're a serious AT user, you live in constant fear of seeing this memory error message:

PARITY CHECK 2

That's your friendly AT's way of saying, "All your long hours of hard work just went down the tubes."

About then you start suspecting gremlins in your AT's memory. The fact is, these errors can be caused by a single bad RAM bit out of a possible 256 million.* The odds are against you.

Whatever the cause, these memory crashes become more common when you add a lot of AT memory or leave your system on day and night—like you do for network file servers, bulletin boards or host emulation.

*Based on 16 megabytes of RAM.

Now the good news. One memory card offers a solution to this potentially disastrous problem: Orchid's ECCELL. And only ECCELL.

KEEP WORKING WHEN THE CHIPS ARE DOWN.

With ECCELL, you're protected against losing all your valuable work due to AT memory crashes. Only ECCELL uses an ECC (Error Correction Code) mechanism to continuously check for errors—and actually correct them before they can do any harm. No other AT memory card does this.

ECC protection has been available on mainframes and minicomputers for years. Now ECCELL brings this sophisticated technology to the AT user.

MEAN TIME BETWEEN FAILURES: Based on 8 Megabytes of RAM memory



HANDLE DOS, PROTECTED MEMORY AND EMS.

ECCELL gives you conventional DOS memory up to 640K. Extended memory that supports protected mode DOS. And expanded memory conforming to the Lotus®/Intel®/Microsoft® EMS standard. Plus ECCELL can be used with other AT memory expansion cards.

DON'T PAY EXTRA FOR I/O PORTS YOU DON'T NEED.

If you need to connect more peripherals, ECCELL offers optional serial/parallel or dual serial ports. Unlike other cards, if you don't need them, you don't pay for them.

ADD 3 MEGABYTES OF RAM PER CARD.

Using multiple ECCELL cards, you can install up to 12 Megabytes of ECC-protected RAM. Installation takes only minutes, guided by an intelligent set-up program.

So don't become the next victim of the AT memory gremlins. Protect yourself with ECCELL. Call (415) 490-8586 today. Or contact your local dealer.

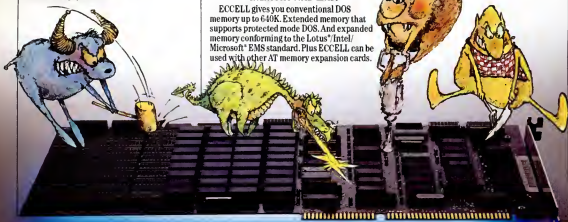
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CIRCLE #2 ON READER SERVICE CARD



■ QUICK LOOKS

Lotus Puts the World in Your Graphs

PC HANDS ON

BY CATHERINE D. MILLER

There's nothing like a map to help your audience get the picture. Lotus Development Corp.'s *Freelance Maps* provides maps for inclusion in the graphics presentations you create with *Freelance Plus*.

Using *Freelance Maps* is as easy as retrieving a file—a map is retrieved like any file created with *Freelance Plus*. You can then use the editing capabilities of *Freelance Plus* to customize and integrate the map into your presentation.

The five *Freelance Maps* sets are simply map libraries stored in the *Freelance .DRW*

format. The U.S. Counties and U.S. 3-Digit Zip Codes sets consist of outline and label

maps drawn to both U.S. and state scales.

The U.S. Major Cities &



Lotus's Maps module works inside *Freelance*, lending the program's graphics editing commands to maps.

MSAs set has outline maps of the top MSAs (metropolitan statistical areas) and maps showing where the largest cities are located. You won't find detailed maps of cities in this set.

The U.S. Complete Set includes congressional districts along with the three individual U.S. sets. The Continents and Countries set covers the rest of the world.

List Price: *Freelance Maps*,

individual sets, \$145; U.S.

Complete Set, \$395.

Requires: *Freelance Plus*, 384K RAM, CGA or EGA, two floppy disk drives (hard disk recommended). Not copy protected. Lotus Development Corp., 55 Cambridge Pkwy., Cambridge, MA 02142; (617) 577-8500.

CIRCLE 428 ON READER SERVICE CARD

QuickPak: A Grab Bag of BASIC Tricks

PC HANDS ON

BY MITT JONES

QuickPak, by Crescent Software, hands you a well-rounded collection of time-saving, tedious-sparing routines that you can plug into your own QuickBASIC and BASCOM 2 programs (a customized version is available for Turbo Basic).

The package includes a mixture of BASIC subprograms and assembly language routines. The BASIC subprograms include code to incorporate Lotus-like menus, bar menus, and windows into your BASIC programs.

Some of the assembly routines—such as sort, search, and print string arrays routines—simply offer greater speed than their BASIC counterparts. Others tap DOS and BIOS services that BASIC can't directly access.

ReadSect and WritSect, which allow direct access to absolute disk sectors, are perhaps the most enticing of these. To write the contents of a 512K-byte string to a sector you simply call WritSect, passing the

string name, drive letter, and sector number as arguments.

The \$69 package supplies assembly language routines in commented source files, object files, and a library file. To include the routines in an execut-

able file, you link the object files separately or load the library into memory when you enter QuickBASIC.

The program also has a 35-page assembly tutorial geared toward BASIC programmers

and a pamphlet of programming tips. Not a bad deal at all.

List Price: *QuickPak*, \$69.

Requires: QuickBASIC, BASCOM, or Turbo Basic. Not copy protected. Crescent Software, 64 Fort Point St., Oslo, Norway, CT 06855; (203) 846-2500.

CIRCLE 427 ON READER SERVICE CARD

Two Clocks That Don't Take Up Slots

PC HANDS ON

BY JONATHAN MATZKIN

Microsync's dClock II or Innovations' SideClock could be a timely purchase if you need a clock/calendar but don't want to sacrifice an expansion slot. They operate just like other battery-backed-up add-in clocks but install without taking up any room on your PC's bus.

dClock II has a female edge connector that plugs into the back of your floppy disk drive, where the controller cable would normally go. The cable then plugs into dClock II's male edge connector. The whole installation takes about 5 minutes.

SideClock installs differently. It does go in a slot, but it's

designed so that you can fit another add-in card in the same slot.

The unit has a number of very delicate contacts that must be seated in the slot "just so" in

dClock II (top) fits between a floppy drive and controller cable, while SideClock (bottom) connects in a slot with any add-in card.



order for SideClock to work properly. And once you've installed SideClock, removing it and transferring it to another system is a dubious proposition.

Software installation for both clocks is quick and straightforward. Both dClock II and SideClock work well, but SideClock definitely requires a bit more care in installation.

List Price: dClock II, \$69.95;

SideClock, \$59.95.

Requires: dClock II: internal floppy disk drive, DOS 2.0 or later; SideClock: expansion slot.

Microsync Inc., P.O. Box 116302, Carrollton, TX 75011; (214) 788-5198. Innovations Inc., 1669 S. Voss, #880, Houston, TX 77057; (713) 879-6226.

CIRCLE 426 ON READER SERVICE CARD

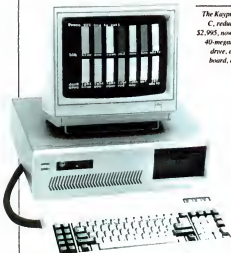
■ PC UPDATE ■ PEGGY GAVAN

Lotus Development Corp. is among the many software publishers announcing support for IBM's **Personal System/2** computers. Although these machines are DOS compatible and run PC-compatible programs, they require 3½-inch disks and offer additional graphics modes. Lotus has released new versions of *1-2-3*, *Symphony*, *FreeLance Plus*, and *Lotus Express* on both 5¼-inch and 3½-inch disks; these new releases take advantage of new features in DOS 3.3 and the new video displays of the PS/2 line. Lotus also intends to offer 3½-inch versions of *HAL*, *Manuscript*, and *Metro*. Registered users of *1-2-3*, Release 2.01, *Symphony*, Release 1.2, *FreeLance Plus*, and *Lotus Express* can upgrade to the 3½-inch disks for \$30. Users of earlier releases can select 3½-inch media when ordering upgrades. For more information on the exchange or upgrade program, call (800) TRADEUP. Lotus Development Corp., Cambridge, Mass.; (617) 577-8500.

Ashton-Tate has begun shipping both 3½- and 5¼-inch disk versions of its software in one package, while continuing to ship the standard 5¼-inch disk versions separately. The retail prices of the packages containing both disks, called Premium Packs, are \$15 to \$20 higher than those of the standard packages: *dBASE III Plus* and *Framework II*, \$725; *RapidFile*, \$420; *MultiMate Advantage*, \$620; *Chart-Master*, \$395; *Diagram-Master*, \$365; *Map-Master*, \$415; and *Sign-Master*, \$265. The Premium Packs also include a Personal Use Extension, which permits personal use of the software on another computer. Registered users can obtain the 3½-inch disks for \$35; the Personal Use Extension is available for \$25. At the same time, Ashton-Tate announced the removal of copy protection from the Graphics Master series, which includes *Chart-Master* and *Map-Master*. Non-copy-protected disks are available to registered users for \$25 (5¼-inch disks) and \$35 (3½-inch disks). Ashton-Tate, Torrance, Calif.; (800) 367-8126.

WordPerfect, Version 4.2, *MathPlan*, Version 3.0, and *WordPerfect Library* are available in the 3½-inch disk format. Current users may upgrade to the new media by sending \$25 along with their old floppy disks to WordPerfect Corp., Update Dept., 323 N. State St., Orem, Utah; (801) 225-5000.

The Kaypro 286i Model C, reduced in price to \$2,995, now comes with a 40-megabyte hard disk drive, a 101-key board, and WordStar 4.0.



IBM has created a stir among the software developers, who rush to re-release new versions of their programs for use with the Personal System/2.



Novell has announced that the new IBM personal computers are compatible as LAN workstations and file servers with *Advanced NetWare 286*, *Advanced NetWare 86*, and *System Fault Tolerant NetWare Levels I and II*, Version 2.1. The *NetWare Workstation Software Kit*, which has the floppy disks necessary for using the new machines as workstations, is free for subscribers to Novell's NetWare electronic information service. Others can order the kits for \$50. Novell Inc., Provo, Utah; (801) 379-5900.

New versions of *SuperCalc4*, *SuperProject Plus*, and *EasyBusiness Systems* accounting software modules are available on 3½-inch disks. *SuperCalc4*, Version 1.1, can display graphics on IBM's PS/2 Models 50, 60, and 80 in the 256-color VGA display mode. All packages from Computer Associates currently in distribution include both 5¼- and 3½-inch disks; registered users who want the 3½-inch disks for the PS/2 can upgrade for free if they are covered by the maintenance plan or if they purchased the programs after February 1. There is a \$20 fee for all other users. Computer Associates Inc., San Jose, Calif.; (408) 432-1727.

ZSoft Corp. has introduced new versions of its software products for use with the IBM's PS/2 computers. *PC Paintbrush*, *PC Paintbrush Plus*, and *Publisher's Paintbrush* now are compatible with the Model 30 in 640 by 480 resolution, 2-color mode and in 320 by 200 resolution, 256-color mode. The software also works with the Models 50 and 60 in 640 by 480 resolution, 4- and 6-color modes. Registered users can upgrade to the new versions (3½-inch disk format) for \$35, \$40, and \$55, respectively. ZSoft Corp., Marietta, Ga.; (404) 980-1950.

Kaypro Corp. has reduced the price of its 286i Model C AT compatible by \$1,000, to \$2,995. In addition, the Model C now comes standard with a 40-megabyte hard disk drive; *WordStar*, Version 4.0; and a 101-key keyboard. The *Kaypro 286i Model A*, priced at \$1,995, also includes *WordStar 4.0* and the new keyboard. Kaypro Corp., Solano Beach, Calif.; (619) 481-4300.

In brief: *Open Access II* supports the PS/2's 256-color mode. Software Products International, San Diego, Calif.; (800) 621-7490. . . . Hewlett-Packard has reduced the prices on its HP Vectra personal computer Models 50 and 60 by 15 percent. The Model 50 was reduced from \$4,695 to \$3,995, while the Model 60 dropped \$700, to a price of \$4,795. Hewlett-Packard Co., Palo Alto, Calif.; (800) 367-4772.

Q&A, OUR #1 RATED FILE MANAGER WAS JUST NAMED THE

It's a red letter day for file management... *Software Digest*, the independent testing service, just rated Q&A™ Version 2.0 the #1

word processor. Q&A beat the best stand-alone word processors including PFS: Professional Write, Multi-

Mate, Microsoft Word, WordStar 2000+, and Word Perfect. Since Q&A is also *Software Digest's* #1 file manager, it be-

comes the only integrated software ever to be rated #1 in two categories.* And once all of you find out, we think EDITOR'S CHOICE those stand-alones could get awfully lonely.

Easy-to-use yet flexible file management. And fast, full-featured word processing. Q&A combines the best of both to deliver a whole new way to keep track of people and information. Manage client lists, personal databases, inventory, tax records, expenses and more. Do customer mailings, write letters

#1 WORD PROCESSOR.

and proposals, include 1-2-3 spreadsheets and graphs in documents, you name it. With our integrated personal file manager/word processor,

custom form letters just don't get any easier. All this plus advanced features like The English

Language interpreter and special hot-links to Lotus make Q&A the value leader in personal software. For now and as your needs grow. In both file management and word processing.†

Call today. We'll send complete information, and while supplies last, a free demonstration disk (suggested retail \$10). #1 file management. #1 word processing. That's a two-for-one offer you can't find anywhere else.

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The File Manager, With a Word Processor, That Understands English

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*Software Digest publishes best-of breed comparison results from The National Software Testing Laboratories, an independent, non-advertising funded organization. Q&A was ranked #1 in File Management in the February 1990 issue and #1 in Word Processing in January 1991. For complete report request info call (800) 223-7082. (800) 223-3315 in PA. †All for very low-cost upgrade offers. PFS: Professional Series, WordStar and Raptor®. Q&A is a trademark of Symantec Corp. Other products are trademarks of their respective holders. © 1991 Symantec Corp.

CIRCLE 251 ON READER SERVICE CARD

■ COMMUNIQUE ■ EDITED BY BILL HOWARD

**Media Notes I:
Power Tools for
Power Users**

A brochure for prospective advertisers in a computer news tabloid shows an executive behind a desk plastered with the usual props—Italian lamps, a high-tech phone instrument, and multiple PC monitors—studiously absorbing a copy of the newsprint tabloid.

The ad copy reads: "[InfoWorld gives] demanding PC managers what they depend on to make decisions—accurate, timely, and comprehensive coverage of the latest developments in a notoriously fast-changing business."

What program is our executive with the ink-stained hands running on his PCs? Cassette BASIC.

**Media Notes II
Speed Kills Hurts**

"[Michael Dell of PC's Limited] plans to introduce his company's 80386, with a speed of 16-20 megahertz. (That's explained by a spokesman as being '16 times as fast as IBM's PC and twice as fast as its AT.')"

—Texas Business, November 1986

**Media Notes III:
Esber, Take a Bow**

"Computer software maker Ashton-Tate said yesterday its ... sales rose dramatically to \$210.8 billion from \$16.6 million in 1985."

—Oakland Tribune, March 4, 1987

Quality Control

A silver sticker attached to the back cover of Zenith's 1986 annual report proclaims, "The quality goes in before the name goes on." The sticker hides a misspelled version of the same slogan.

**The Spell Checker
Never Beeped****Excellence Defined**

"If your looking for the best in EGA graphics business presentations or simply the best paint program available—EGA Paint is the answer."

—RIX SoftWorks ad

Princeton Graphics

A magazine ad for Toshiba's T3100 portable AT compatible ("Toshiba. Beautifully Intelligent.") features Princeton senior Brooke Shields sitting at her desk with paper, pencil, composition book, a paperback edition of *Madame Bovary* (a future role?), and the \$4,199 Toshiba that's helping Princeton's most famous virgin with her composition. The T3100 screen depicts a mysterious 3-D Perspective graph, none of whose axes are labeled.

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—Training guide, Micro MRP (emphasis theirs).

Heard or seen anything offbeat, unusual, or just plain dumb about the computer industry? Send your offerings to *Communique's* PC Magazine, One Park Avenue, New York, NY 10016, or MCT Mail 157-9301. Contributors receive \$30 and a PC Magazine T-shirt. Please don't submit any more entries for sloppy drives, cereal printers, or hazy models. In case of duplicate entries, the earliest postmark prevails. Sorry, but entries can't be acknowledged.

Winners this issue: Stephen Manes (Brooks Shields), Paul Somerson (InfoWorld promo), David Poole (Michael Dell), Steve Offner (accuracy), Lowell Allen (RIX SoftWorks), Karel Newman (Ashton-Tate), R. D. Milne (problem solver).

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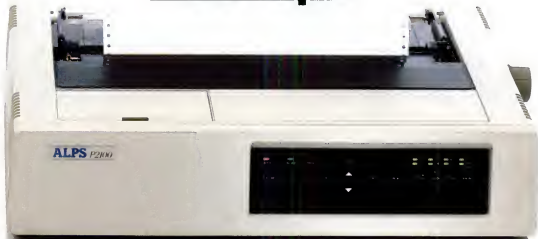
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■ FROM THE EDITOR'S SCREEN ■ BILL MACHRONE

THE MEMORY MUDDLE

Nearly 2 years have elapsed since Lotus, Intel, and Microsoft first introduced the expanded memory specification. The confusion hasn't stopped yet.



When Lotus and Intel first announced the expanded memory specification, it was aimed at one simple problem: 1-2-3 spreadsheets often ran out of room in the PC's 640K memory space. The solution was to use bank-switched memory, a time-honored method of adding more memory to a computer than its basic architecture allows. The operating system is usually the control point for memory requests and allocation, but MS-DOS had no such facilities. Beyond the ability to load a driver that served as a common reference point, DOS had no knowledge of what the EMS manager was doing. So the applications programs undertook the task.

In order to promulgate the spec, Lotus and Intel formed a unique alliance. Together they proselytized the industry, gaining acceptance from hardware and software manufacturers. Intel approached the software companies, many of whom competed with Lotus. Meanwhile, Lotus palavered with the hardware companies, all of whom competed with Intel. Microsoft added its imprimatur to the spec late in the game, and begrudgingly. Microsoft knew, of course, that memory management was properly a task for the operating system, not applications software. But it also knew that an operating system ready to undertake memory management was years away. If it was to have any say in the future of memory management, it had to get on the bandwagon. Microsoft's participation changed the name of the spec. While it continued to be called the expanded memory specification, it was also known as the

Lotus/Intel/Microsoft (LIM) spec.

The original EMS spec was so tightly focused on Lotus's needs that it could handle only a single task. Proponents were quick to realize that there was room up there for RAMdisks and print spoolers, too, and that they should all be operable at the same time. So the spec was revised almost before it was issued. The current version permits RAMdisks, print buffers, and applications programs using EMS to be active simultaneously.

Meanwhile, not everyone was sold on the Lotus/Intel spec. AST, in particular, felt that the small page size and the number and size of pointer registers were too limited. One side says it voiced its objections too late in the game. The other side says it was ignored. In any event, AST and Quadram introduced the enhanced expanded memory specification, a superset of the original Lotus/Intel spec. EEMS has a larger page size than EMS and some addi-

tional pointers that help it manage multiple tasks better. EMS programs run under EEMS, but not the other way around.

For a time, the only application to make use of EEMS's greater capabilities was Quarterdeck Systems' *DesqView*. Several new products, due to emerge in the coming months, will use EEMS's larger page size and better support of multitasking to gain significant speed improvements and to "hide" larger pieces of programs in expanded memory.

The need for expanded memory doesn't go away with the emergence of 80286 and 80386 operating systems. The whole point of a protected-mode operating system is to break the 640K barrier and to give applications as much memory as they need. Along the way, it also introduces multitasking. But the new operating systems also allow old applications to run. To the extent that old applications use expanded memory, the new operating systems must permit access to it. While it's unlikely that many protected-mode applications will be written to take advantage of expanded memory when they already have access to extended memory, I firmly believe that there must always be some memory in the system that DOS doesn't know about. That flies in the face of conventional wisdom and rational operating system design, but user needs will always outstrip operating system abilities. And there will always be clever programmers who glory in bypassing limitations, whether they're intentional or accidental.

For example, take a look at terminate-and-stay-resident (TSR) programs. We are



■ FROM THE EDITOR'S SCREEN

now on the verge of seeing a resolution to the long-standing conflicts among them. Both Lotus and Borland are hot on the trail of an API (applications program interface) that will operate as a mini-operating sys-

tem for TSRs. Think of it in terms of a master TSR program that serves other TSRs and takes care of all the difficult stuff such as writing to disk and windowing. It also establishes a set of rules of behavior

for TSRs and puts an end to the conflicts, once and for all.

THE BEST TRICK No matter how much memory you have, it will always be a scarce resource. The operating system may not allocate it the way you want. That's why it makes sense to continue to have some extra at your disposal. The TSR APIs will know how to swap TSRs in and out of main memory, and they'll need some place to swap to. A hard disk is too slow: the whole point of pop-ups is immediacy and the convenience of having utilities just a keypress away.

The new multitasking operating systems are designed to keep applications programs from interfering with one another. The purpose of many a TSR program is pointedly to interject itself into the normal processes of transient programs. The question now is how to integrate the undeniably useful features of TSRs into the advanced 80286 and 80386 environments.

Rewriting TSR programs as standalone tasks is not a solution. Many TSRs are inactive until they're popped up. Wasting a multitasking environment on them doesn't make a whole lot of sense. Those that are active all the time need to monitor things like keystrokes, the screen, serial port activity, and the system clock.

Most of these new operating systems include methods for intertask communications, so that one program can talk to another, share keystrokes, or otherwise interact. The problem is mixing old and new technologies. It may be easy to rewrite a resident program to use these services, but what good is intertask communication if only one side is communicating?

A likely solution for the 80286 is for the TSR API to "bind" itself to the operating system, so that it can survey all system activities. It will need memory that no other application can touch. The 80386, meanwhile, has on-chip memory management and virtualization hardware, and it can emulate EMS and EEMS memory just as easily as it can access its normal extended memory. So while EMS remains valid for 386 machines, it may not require a special memory board.

In any event, the competition for your memory dollar isn't over yet. In fact, it's barely begun. □

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■ JOHN C. DVORAK

THE SUBSTANCE OF IMAGE



There is more to image than meets the eye. Can the IBM Personal System/2 compete with the sleek image for which the Mac is already known?

What if I told you that time is running out for the user of the IBM PC? And what if I told you the new Personal System/2 won't help? And an Apple user will make an IBM user pale by comparison? What would you say? You'd probably say, "What the heck are you talking about? We're IBM users. If we don't use the PC, then we use a speedy clone. The kind of computer that computes rings around an, ugh, Apple."

Even with the release of the new IBM machines and IBM's final adoption of PostScript as a character definition standard (and quasi-language), it will take years for the stodgy users of these machines to keep up with the fast lane go-for-broke yuppies who are storming ahead with their Macs. Yes, Macintoshes.

We take the Mac for granted because too often we hear a gushing, aimless argument about how the Apple Mac, because of its graphical interface, is a superior machine to the IBM-type computer. The argument is promulgated by bug-eyed Mac-Zombies who haven't got the faintest notion as to the meaning of an "A>" prompt. In fact, the word "prompt" isn't in their vocabulary. They think it's something people do on TV.

We think that these MacNazis, who walk in lockstep like drones to some unheard drummer pounding away in Cupertino, are fools. Perhaps many of them are. But like National Socialist Brownshirts of old, they turn out to be a crowd of bullies who try to distract us from other realities.

First, they divert us from the fact that far too many whiz-kid programmers,

hackers, and tic-plagued fanatics (who write code like nobody's business) love the Macintosh. Have we ever wondered why this is? "Oh, it's because they hate IBM. It represents the establishment." Right. And all programmers are a bunch of Communists. I don't think so.

It's because the Mac offers the power these maniacs crave. The results achieved on a Macintosh from a hard day's work of programming are stunning. Stunning from the standpoint of "image." Like artists, the best programmers are into image—just plain showing off. It's *exactly* the same goal desired by today's businessman—image. Hot, now, happening, today, slick, cool, groovy, and "with it."

Here's my analogy. Just scrutinize one of those TV retrospectives where they show you old commercials and 1950s station IDs and program titles. The mediocre, amateurish "look and feel" of the graphics is pathetic. "Hokey" is a good word to

use. Nowadays, fancy, full-motion, computerized, chrome-plated-looking, spinning and merging, outrageous graphics are the rule, not the exception. Anything less and you look like a rube from Iowa.

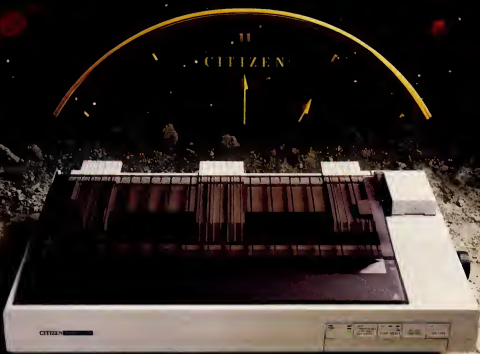
Folks, we've upgraded our "image" from routine to exceptional. The exceptional is now routine and the routine of old is now tawdry and drab. The world of the Selectric typewriter. The best word is "dowdy." Dowdy is the world of the IBM PC and today's businessman who doesn't demand an upgrade in image—an upgrade that Apple is giving its customers who are willing to drop some dough into a LaserWriter and its slick output. The option wasn't available for the PC world, except from HP with its popular Laserjet.

The Laserjet, when compared to a LaserWriter, is also dowdy. Its default font is Courier—from the Selectric—thus reflecting the true function of the Laserjet: it's the world's fastest typewriter.

The Apple printer demands you use something slick and fancy—modern typefaces. Something that improves the image.

Image isn't important, say some. Substance is important. One of these days, the detractors will realize that image and substance go hand in glove. Sure you can fake image for a while, but sustaining images reflect great substance. The arts and mass media have shown us that to compete, you have to somehow prove you are up to speed. You have to qualify. Image is the qualifier. Then the race begins. Without image you can't even participate. Even with the new products, IBM is leaving us stranded—on the sidelines.





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■ JOHN C. DVORAK

INSIDE TRACK

The IBM Personal System/2 announcement brought no surprises except that there were no surprises.

Now's the time to try to digest the recent IBM announcements of its **Personal System/2**. Most of the insiders are saying "it's no big deal" or "it's nothing special." Both comments are true, to some extent, but colored by the new IBM pricing. Imagine if all the machines were priced \$1,000 to \$2,000 less than the IBM prices? What would people be saying then? **There'd be panic, blood in the streets, banner headlines, mayhem.** By this time next year, *PC Magazine* would have shrunk to 10 pages of ads. All of which would be for companies announcing bankruptcy sales. Is that what people want to see? You'd think so, from the hypercriticism IBM gets from all corners.

IBM marketers will obviously never get into a real battle on the low end. The company has over 35,000 salesmen and over 400,000 employees it has to feed. **That means things can't be cheap.** They leave the prices high and hope that the 35,000 salesmen and the 1,000 independent dealers can move the goods. End of lecture.

Now let's talk about these machines. Revolutionary, no. Evolutionary, yes. **So what else is new?** Everything was predictable from the 3½-inch disks to the surface mount chips and VLSI.

I think most people were surprised by the fact that IBM didn't make the ROMs weird and make the new operating system proprietary. **There was internal bickering** over this issue. Some managers in the rank and file at IBM wanted to seal off the competition. This is especially true of the managers who had to explain the encroachment of the clones at meeting after meeting. But the winners of the political battle were the big machine honchos who could care less

about microcomputers. They are interested in connectivity.

"The real power at IBM is still held by the group that sells heavy iron," I was told. "They do not want IBM to close the architecture of the personal computer."

They want to sell big monster mainframes. The key for them is connectivity. They could care less whether some guy at Standard Oil uses a clone or an IBM PC as long as it's hooked to the big machine and chewing up machine cycles.

To these guys the desktop machine is just an expensive terminal that eats mainframe MIPS. They want to make sure it's an IBM mainframe whose MIPS it eats, and that to them means the whole PC family is just a skill, luring everyone into PC compatibility and IBM connectivity.

If the PC were made into a proprietary machine, who knows what would happen? "Don't fix it if it ain't broken" is their motto. So they got their day and things are still rosy for everyone.

Aside Dept.: Now, if someone can tell me why IBM chose to hire the old cast of "M*A*S*H" to promote the new line, I'd be thankful. I sure can't figure out the logic unless some executive wanted to get a date with Loretta Swit.

Whither the 286 Dept.: As I mentioned a few columns ago, Intel is working on a 16-bit version of the 80386 that is pin compatible with the 80286. Expect it around summertime. Now I find out that the company is planning to make a **80387 that is pin compatible with the 80287.** The company has seen that many 80386 designs have an 80287 socket for eventual placement of a floating-point chip. So Intel says, "Hey, why not make a 80387 chip that fits in there?" I like the way these guys think.

One such 80386 motherboard with the 80287 socket is floating around those garage clone operations—the **Four Star motherboard 80386 screamer.** After using it (hooked up with a fast hard disk), I admit that this is the way to go. The 80386 chip is built for speed, plain and simple. Nothing has to be pushed. Who cares if it doesn't have a new operating system? I'm recommending 80386 systems to anyone who can afford the ticket. **One day we'll look back at the 80286 the way we remember the 16-bit mini-computer—as a stopgap.**

Laser Mania Dept.: I still wait for the \$499 laser printer. I may be waiting awhile. While waiting, look for a surprise entrant into the laser sweepstakes: **Matsushita** (aka Panasonic). It seems as though the big boys in Japan have decided to enter the market in their usual way: by blowing their brethren out of the water. The machine has gobs of memory, 10 pages a minute, 300 dots, and is possibly compatible with HP and *PostScript* too! Matsushita makes the engine. The price? I'm guessing \$1,500, maybe less.

Cajoling the Media Dept.: Have you ever thought about running a small software or hardware company and wanted to save the thousands of dollars it costs to get some decent PR? Or are you a PR person who wants the latest dose on the way Jim Seymour thinks about life and press releases? Well, anyone interested in PR for this business should subscribe to a **huge binder full of facts** published by Cambridge Communications. Called *MediaMap*, it comes out quarterly and contains about 700 pages of detailed information about all the writers who deal with microcomputers and all the publications they write for. It's an amazing tome. The price is a hefty \$1,200 for a year's worth of binders, but it's well worth it, believe me. Contact Cambridge Communications, 124 Mount Auburn St., Cambridge, MA 02138; (617) 643-5700.

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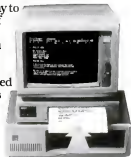
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■ JIM SEYMOUR

INCREMENTAL VS. GENERATIONAL CHANGE



Hardware manufacturers have to make tough choices when upgrading existing models—maintain an upgrade path for current customers or take a daring step forward.

A few pages further on in this issue you'll find my colleague Stewart Alsop chastising both Compaq and Apple over their distressing failure to provide an upgrade path for users of current machines.

Go get 'em, Stewart; I agree completely. Like Stewart, I also own an old-fashioned 8-MHz Compaq Deskpro 286—instantly old-fashioned as of the moment Compaq discontinued the 8-MHz machine a couple of months ago. Also like him, I was sorely disappointed that Compaq's move to 12 MHz and a new motherboard for the Deskpro 286 didn't include any relief for those of us who must now creep along at 8 MHz—no matter that 8 MHz looked pretty snazzy the day before the Compaq announcement.

On the other hand, I also own a 512K-byte Mac, but I suffered very little pain at my inability to turn it into at least a Mac SE, let alone the machine that I really want, the Mac II.

WHAT'S THE DIFFERENCE? The move to a 12-MHz 286 desktop machine from Compaq was incremental change, an evolutionary improvement. The Mac II represents generational change, a real leap forward for the Apple Computer company, its users, and the microcomputer industry as a whole. The distinction is damned important.

When I encounter the kind of generational change evident in the Mac II, I don't expect hardware or software vendors to let me turn my electronic sow's ear into their new silk purse. I don't want them to com-

promise the genuinely revolutionary leaps forward of the new product by shackles to the past.

But when a vendor introduces incremental changes, I damn well expect that vendor to take me along. I expect a vendor to make it possible for me to upgrade my hardware to the new model, or to upgrade my software to the current release level (and to take my existing files and macros along). Otherwise, I'm going to be one surly customer indeed the next time someone tries to sell me something from that shop.

The problem is particularly aggravating for those individuals and companies who bought PCs for use in business and who are still depreciating them (and may have taken an investment tax credit for all or part of the purchase cost), and therefore they can't blithely dump the old and pop for the new without unpleasant tax consequences. In large corporations—in which the capital-

goods acquisition cycle means planning far ahead for capital investments in items such as personal computers—users can almost always find ways to upgrade existing boxes but they find that tossing an 18-month-old PC out for a new one is nearly impossible.

The angst of the PC user who feels left out of a vendor's plans for the future is not a pretty thing to see. For every unhappy customer, however, there is a market opportunity for third-party companies, which invariably rush to fill the breach.

It's interesting to see how far vendors will go to allow customers to upgrade—often making available upgrade paths that make questionable economic sense but offer comfort and reassurance to customers.

When Hewlett-Packard brought out the Laserjet Plus, for example, which finally had enough memory to begin to do serious (if still less than full-page) high-resolution graphics, owners of the original Laserjet were envious. But HP kept 'em in the fold by offering a replacement motherboard for their machines. The new board replaced the Laserjet's memory-shy controller with one duplicating exactly the features of the Laserjet Plus.

The fact that the new motherboard was very expensive wasn't so important compared with the respect HP showed for its customers' goodwill. At \$2,000, almost as much as many Laserjet customers had paid for their whole printers, the economics of the upgrade board was marginal. Instead, users could have left their original Laserjets intact, used 'em as quick, quiet de fac-



■ JIM SEYMOUR

to Diablo 630 letter quality text printers, while adding another grand to the cost of the replacement board to get a real Laserjet Plus—a second complete printer—at its prevailing street price of about \$3,000.

But not everyone *wants* two laser printers, despite the economics of the matter; and Hewlett-Packard didn't push its customers into doing something they didn't want to do.

SOFTWARE UPGRADES In software, we've seen relatively few examples of incremental change without easy, relatively inexpensive upgrade paths for existing users—including file portability. In the most-celebrated recent brouhaha, Lotus's move from Release 1A to Release 2.0 of 1-2-3, users were chagrined to find that Lotus had made both obsolete and unusable many of its existing macros. Macros are at the very heart of using spreadsheets for many users, and so those users screamed. We eventually saw the advent of Release 2.01, which fixed many of those problems. Even Lotus listens sometimes; even Lotus changes.

Especially for hardware designers, building full compatibility into a new version of a product with earlier iterations of the product can be a nightmare. Making a separate upgrade part that allows users of old hardware to update their equipment to match the specs of the new can be an order of magnitude worse.

It's easy to say "tough, that's why we pay you guys so much money," but in fact, our best interests as PC users aren't always served by burdening the people doing the new version with the albatross of the old one. Too often that leads to bad design decisions—poor compromises that forfeit the real improvements we need in new products.

In incremental, evolutionary new versions, that kind of suboptimized improvement—suboptimal in the interest of maintaining upgradability—is tolerable, maybe desirable. But it's completely unacceptable in generational-change products, those revolutionary improvements through which the PC business lurches forward in big leaps.

Could Compaq have provided a way for Deskpro 286 users to upgrade their machines to the 12-MHz speed of the new model? Not by selling them motherboards; too much else would have had to be changed. But an add-in upgrade card might have worked. As, for that matter, might a 386 upgrade card. Are you listening, Canon, Stimac, et al.? Why drive us straight into the open arms of Orchid, Intel, and other manufacturers of faster add-in boards when you could have kept us True Blue . . . er, make that True Houston?

I'd score it: Apple 1, Compaq 0.

PC BRAND PRESENTS**RYAN-McFARLAND'S
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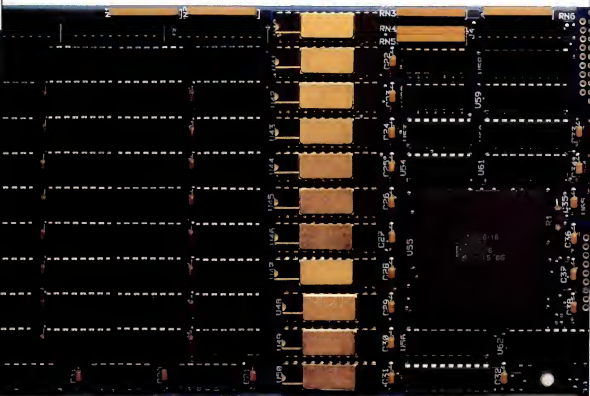
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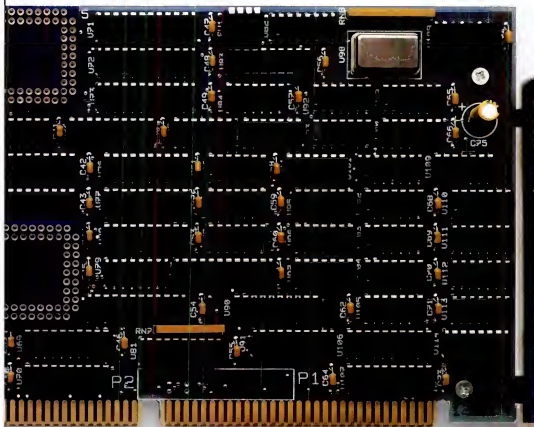
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■ STEPHEN MANES

HYPertext: A BREATH OF AIR FRESHENER



As buzzwords go, hypertext has everything it takes: a catchy sound, the promise of better days ahead, and the potential for total confusion.

The claims for *hypertext*, this year's "visionary" computer buzzword, are like a breath of air freshener. At first the bracing "mountain-clean scent" wakes you up; a moment later you realize everything in the room has the dubious odor implied by the quotation marks.

Computer savants see nirvana in a mon-itor, then spend the rest of their days publicizing it. It's generally agreed that the term *hypertext* is the brainchild of computer guru Ted Nelson, whose goal seems to be putting all human experience on-line so that humans need never do anything but stare at screens. In honor of our graphical age, this "nonidea that will not die" has been inflated to *hypermedia*.

No matter. If there is a central idea here, it's so simple that nongurus aren't likely to get all tingly over it. Essentially, hypertext is a way to link disparate fragments of information. What this translates into in most current hypertext demonstrations is something like this: click your mouse on a listing in the table of contents and the article magically appears on your screen; click on the word IBM in the article and a cartoon ogre shoots itself in the foot; click on the secret word and the duck comes down.

Sound familiar? Of course it does. The help screens in 1-2-3 are prime examples. So are the context-sensitive help-plus-tutorial features of *Microsoft Word*. Nobody called them "Breakthroughtext" when they arrived. So what's the big deal?

KEEP OFF THE GRASS Hypertext gurus claim this technique is in fact a whole new medium. The way it can link ideas in

separate documents is supposedly "non-linear," more like human thought than boring old "linear" books. "Multilinear" is probably more accurate: you can follow any number of predetermined Paths of Knowledge, but you can't easily walk off them and onto the grass of Unlinked Information. In fact, you may not even be able to see the grass.

For didactic purposes, that may be just fine. I've seen demonstrations of June Austen and Robert Browning databases, with scads of historical and cultural information available at the click of a button. In these examples, the main difference between hypertext and an old-fashioned "teaching machine" is that hypertext offers a multiplicity of paths instead of just one. This sort of system may function as a sort of "programmed learning" that doesn't seem quite as "programmed" as earlier systems—a difference whose parallel might be the difference in Russian free-

dom under Khrushchev and Gorbachev.

However, in the grand unified theory of hypertext, all human knowledge would be available on some giant computer, and users could generate their own "democratic" series of paths, follow the path some great scientist used, you name it. One trouble, aside from the trivial problem of computerizing all this data, linking it, and disseminating it, is that sooner or later there are so many paths that users end up spending most of their time guessing which ones might actually be useful.

A MAJOR PROBLEM How to create the initial links remains a major problem with hypertext. With a small system, humans can do the work; still, this invites the errors and omissions that creep into paper indexes. If the indexer leaves something out, you'll find it only by browsing.

Free-text searching—the ability to use the computer to sift through files that contain a particular combination of words like "comedian and cigar"—tends to cast a wider net but can be just as likely to omit important information. In this example, you would miss articles on Groucho Marx that happened to omit one of the two key words you were searching on. But this form of search—and more likely the more extended approach used in a promising PC program called *Personal Librarian*, which lets the computer algorithmically broaden your search and estimate the relevance of the articles it finds—is probably essential to making any big database truly useful.

The skeptic may be pardoned for thinking that hypertext encourages irrelevance.



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■ STEPHEN MANES

What the user can end up with is little more than a series of footnotes, marginalia, and "see also" references—items that have historically been relegated to second-class citizenship in the good old book format, with the added benefit of not having to stare at a lousy screen display to read them. The argument that one can employ hypertext techniques to create wildly complex multimedia "documents"—say, a frame-by-frame exegesis of *The Texas Chainsaw Massacre* and its subtle relation to the brushstrokes of Monet, the concepts of Wilhelm Reich, and the dissonance of Spike Jones—is not without interest, but not exactly something you couldn't do with a videodisk and a book. Indeed, when you boil it down to its rudiments, hypertext seems to make one major claim: it makes computers work almost as well as books.

CHANNEL-HOPPER In fact, hypertext may work almost as well as your TV's remote channel-selector. Studies have already discovered that long blocks of text, or those that express more than one idea, don't work well at all in hypertext systems. No surprise: since you can exit the "main line" document at will, you're likely to "change the channel" at the earliest symptom of boredom—an excellent way to hit the world's cultural high points but avoid anything resembling depth.

Despite the theoretical "creativity" of "nonlinear" thinking, good thinkers tend to use boring old linear logic more often than not. Despite the 20th-century avant garde's inclination to believe that there is some sort of magic to multimedia and cubistic approaches, there is ample prima facie evidence that the stodgy linearity of "a good yarn," "a tune you can hum," or "step-by-step instructions" satisfies some innate human need for order. There's also something to be said for the dumb linear idea that "you're done"; with hypertext, there's always another alley of exploration, more often than not, a blind one. A recent article on hypertext showed how with four simple clicks anyone could whiz from an article on indoor lighting to a totally unrelated piece on diamonds; what the article omitted to say was why in the world anyone might want to.

Hyperbole to the contrary, hypertext doesn't seem to be a new medium; it may

not even be a medium at all. As a way of looking at the adaptation of some simple, useful, and fairly long-standing techniques to computers, it does have something to offer. But the term has been around for more

than 20 years, and the implementations thus far have been less than dazzling. Maybe it's time for the hypertext hypers to stop making artificial pine-scented claims and let in a few gusts of sanity. □

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■ STEWART ALSOP

MOTHERBOARDS AND APPLE PIE



The American Dream keeps us moving forward, exercising the right to go yet another step further. Maybe it's time to establish the right to an upgrade.

I like computers. I really do. I know I complain about them a lot, but that's only because I use them so much. In fact, I like computers so much that I had to move into a new office to get enough space to set them all up. (All six of them: that is, two PCs (a Compaq Deskpro 286 and an AST Premium 286), two Macintoshes, an Atari ST, and a Commodore Amiga.)

But last week I began to get really irritated. I mean I began to get angry. Last week three computer manufacturers obsoleted me. Well, actually, they obsoleted two of my computers.

The two manufacturers were Compaq and Apple. Compaq introduced a new version of the Compaq Deskpro 286 desktop computer, which features a 12-MHz 80286 processor. Apple introduced a new Macintosh Plus called the Macintosh SE, which has a built-in slot and hard disk and is about 20 percent faster than the ones I've got. The reason they obsoleted my computers is that neither company gave me a way to add these new features to my existing computer.

As many of you know, I bought a Compaq Deskpro 286 just about a year ago. It's an 8-MHz model, which was a real screamer at the time. The 80386 processor hadn't been officially announced yet. IBM was still selling a 6-MHz computer based on the 80286. And PC's Limited had just introduced its 10-MHz version. I got my Deskpro from 47th Street Photo, so I got a good deal on it, and it has served me well.

Being on the leading edge is important to me, since my job is to know what's happening in the computer industry. I figured

that I could get a good 2 or 3 years out of my Compaq before I would begin to feel that I was falling behind and had to acquire a new computer. Now here it is just 1 year later and Compaq has managed to introduce three new computers in the interim: the Compaq Deskpro 386, the Portable III (also running at 12 MHz), and the Deskpro 286-12.

The Deskpro 386 is a different class of computer: it has a different processor, and Compaq built a new bus into it so it could use fast 32-bit memory. And it was priced at nearly twice as much as my computer, so it didn't affect me. The Portable III is a different kind of computer, one that you're supposed to lug around from time to time, which you definitely don't do with a Deskpro 286 (which weighs 58 pounds according to Federal Express). So the Portable III didn't affect me either (although I did wonder what people who had bought a Portable II thought of the III).



OUT IN THE COLD But the new Deskpro 286 is essentially the same computer I bought a year ago: same price, same box, same basic features with the single exception of a different version of the processor that runs about 50 percent faster than the one I have. In fact, it replaces the Deskpro 286 that I bought as Compaq's mainstream desktop model. So I now own a computer that's no longer being manufactured by the company that made it.

I'm a reasonable person and fully understand Compaq's need to remain competitive. But I also expect to be treated like a rational, intelligent, paying customer (even if I did buy from 47th Street Photo). While my computer is just as useful as it was 2 weeks ago, I feel as though Compaq has just thumbed its nose at me and said, "You fool, you should have waited."

The problem is that Compaq has given me no way to get the higher-speed processor that it trumpets as being so important. Indeed, as far as Compaq is concerned, I must go out and buy a new computer if I want to run my programs 50 percent faster than I do now. Of course, if I asked president Rod Canion or one of his Canonities, Compaq would probably tell me that I could just as easily buy a 12-MHz accelerator board for my old computer and get all the benefits of the new model.

But Compaq doesn't make accelerator boards for its customers, and from everything I've heard about upgrading computers, the add-on boards that create the most problems are accelerator boards, since they make a computer run faster than it was designed and tested to run. I've had

■ STEWART ALSOP

enough problems with my computer without taking chances on boards that might mess it up in mysterious ways.

It would be easy enough for Compaq to solve this problem by making and selling

me an enhancement board that it certifies or at least by certifying another company's accelerator board. What I would like better, though, is a sense that Compaq really does care about the fact that I bought its

computer a year ago and that it is actively thinking about how to keep me current.

IT'S JUST NOT CRICKET The reason I want this is because I happened to be in London last December and discovered a British computer company that is developing just that sort of awareness of its existing customers: Apricot Computers Plc.

Apricot used to make a generic MS-DOS computer that wasn't completely compatible with the IBM. As with U.S. companies selling similar semicompatibles, Apricot began to get into trouble in late 1984 because the British started buying IBMs and strict compatibles. Last year Apricot introduced a completely compatible, high-performance machine called the Xen-i. The company designed the motherboard of that computer to be exactly the same size as the motherboard of its older MS-DOS computers and offered its 100,000 existing users a simple motherboard swap so that they could switch to a fully compatible computer without buying a whole new machine.

Apricot went even further: it publicly committed to continue introducing new computers based on the same-size motherboard so that, when it introduced an 80386-based machine, not only its MS-DOS customers but its 80286 customers could swap motherboards and stay completely current. Apricot's customers have reacted enthusiastically, giving the company a solid third-place position in the British market, behind Amstrad and IBM.

The question I have is: Why can't a class company like Compaq do the same sort of customer-sensitive product planning and give people like me a reliable, comfortable way to bring my machine up to date? The basic idea of swapping motherboards is not unheard of. Indeed, Apple—the other company to obsolete me last week—has done it twice, first with the upgrade from Macintosh 512 to 128 to Macintosh Plus and second with the upgrade from Apple IIe to IIs.

With a motherboard swap for my 8-MHz Deskpro, I wouldn't worry about accelerator boards or popping chips off my existing motherboard, and I'd have a clear indication that Compaq appreciates my business and wants to keep getting it. Is that too much to ask?



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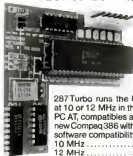
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TECHNICAL KNOCKOUTS:

Why Everyone Needs a Hard Disk

All that most people need to know about hard disks could be summarized in one short maxim: if you don't have one, get one. In the 6 years that the hard disk has been available for PCs, it's gone from being a luxury to a necessity. Prices have tumbled from more than \$100 per megabyte to \$10. Single-disk-drive storage capacities have outdistanced the design limit of DOS by almost a factor of 12. As a result, adding any hard disk to a PC that lacks one will make the system faster and more convenient. If you bought your computer to speed your work and make it easier, that's a winning combination.

A hard disk makes using your PC more convenient because you don't have to play the floppy disk shuffle every time you want to load a program or save a file. With a hard disk, all of the programs you regularly need are instantly ready to run. Compared with floppy disks, the storage capacity of a hard disk seems almost limitless (at least for the first few weeks). The large storage capacity also means that you can work with files that are millions, instead of thousands, of bytes long.

Adding a hard disk, with its vast storage capacity and quick retrieval of files, to your PC will undoubtedly make your life easier. To pick the right one for you, you'll need to know about the principal variables involved. Here's how to avoid the floppy disk shuffle.

■ HARD DISKS

Hard disks are able to save and retrieve programs and data much faster than floppy disks. In fact, more than any other peripheral, the disk storage system determines how responsive a computer will be. With many applications, the speed of the hard disk will have a greater effect on system throughput than the microprocessor or its clock speed. Running an AT without a hard disk is like trying to compete in the Tour de France on a balloon-tire Schwinn bicycle—getting anything accomplished is more a matter of miracles than ability.

In addition, today's hard disks are cheap. With a hard disk you get more bytes per buck than any other single storage medium, including RAM or the floppy disk. Twenty megabytes, currently the most popular hard disk size, can cost as little as \$400. Only the tightest of budgets can no longer afford the benefits of hard disk capacity and performance.

Like the term PC itself, the label *hard disk* covers a dazzling array of products with a wide range of performance levels, prices, storage capacities, and even philosophies. The categories of hard disks themselves are evolving with the personal computer industry.

For instance, once the low end of the hard disk market consisted of 10-megabyte disk drives and associated hardware packaged by systems houses and sold in the \$1,000 price range. Today, you're more likely to buy a bare disk drive or hard disk card directly from your dealer or a mail-order distributor, install it in your PC yourself, and end up paying less than \$500 for twice the storage. Yet the traditional hard disk distribution channel still survives where convenience and support are more important than budgetary considerations—and particularly where disk capacities and costs are so large that mistakes are ill affordable.

THE PERFECT DISK Finding the perfect hard disk—the one that's right for you—requires that you match its features to your own needs. The first decision you'll need to make is the one that's always the most difficult—how much to spend.

If money is no object—or if you're willing to pay somewhat more for additional security—you may want to consider

a completely configured hard disk subsystem from a system integrator. When cost becomes the overriding issue, you'll more likely want to do everything yourself, buying the disk drive—and the controller if you need one for your PC or XT—from your dealer or favorite mail-order source.

No matter which route you choose, the price you're willing to pay will also influence the amount of storage capacity available to you. In general, more buys more. Sometimes, however, one disk drive may offer particular features, rather than increased capacity, that more than justify a higher price. Performance may be one such factor. The data security won with the proper design choices may be valuable to you, too.

■ **Finding the perfect hard disk—the one that's right for you—requires that you match its features to your own needs.**

HARD DISK BASICS To sort out what you need from what you don't, you need to understand both the nomenclature of the hard disk and the basics of its operation. Once you understand what goes into the typical hard disk drive, you'll be able to make an enlightened choice among the various competing products.

The hard disk is actually a combination device—part electronic and part mechanical. Electrically, its function is to turn fleeting digital electronic pulses into more-permanent magnetic fields. It does so by using an electromagnet, called a read/write head, to align the polarities of magnetic particles on the hard disks themselves. Other electronics properly arranges the magnetic storage and helps locate the information stored on the disk.

The mechanism of the typical hard disk is actually rather simple, containing fewer moving parts than the average electric ra-

zor or pencil sharpener. The basic elements of the system include a stack of one or more platters—the actual hard disks themselves—that rotate as a unit on a shaft, called the spindle. The shaft connects directly to a servo-controlled motor that spins the entire assembly.

The only other moving part in most hard disk drives is the head system. In nearly all disk drives, one read/write head is associated with each side of each platter, and each head is connected to an arm linked to all the rest of the arms of the other heads to form a single moving (usually pivoting) unit. The head assembly is swung across the disk by a special solenoid or motor, called the head actuator.

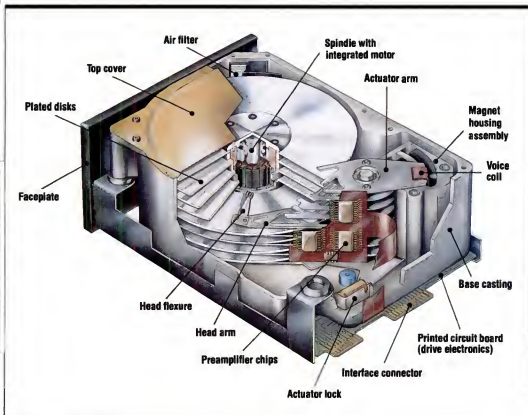
Unlike floppy disk drives, the hard disk platters constantly spin (at least while powered-up) because it takes the substantial spinning mass of the hard disk platters a significant time—10 to 30 seconds—to achieve its relatively high rotational rate (usually 3,600 rpm). The constant spin makes your data nearly instantly accessible (with floppy disks, you have to wait the half-second or so it takes to get them turning at the right speed).

The constant spin also extracts penalties—constant current consumption high enough to preclude the use of most hard disk drives with the paltry 62.5-watt power supply of the (now discontinued) ordinary IBM PC. In addition, the constant, high-speed spin makes the quality and performance of the bearings holding the spindle of paramount importance. While in general these bearings are sealed, permanently lubricated, and trouble-free, some inexpensive hard disk drives have shown a propensity for bearing problems.

The principal variables in hard disks relate to their speed and capacity, and these qualities are directly related to design choices in making the mechanism. The head actuator has the greatest effect on the speed at which data can be retrieved from the disk, the number of platters exerting a smaller effect. Capacity of the hard disk is influenced by the number of platters, the magnetic material on the platters, and the head assembly.

PICKING A RANDOM BYTE Unlike microprocessor performance, disk speed is not a simple issue controlled by one or two

■ HARD DISKS



Hard disks today and tomorrow: Aside from an ever-increasing number of platters (eight in the illustration above), the most recent innovations in hard disk technology are the coating scheme used in the construction of the disk platter and the type of read/write actuator used. Many manufacturers now plate the surface of the disk, making it a more

reliable storage media. The older scheme uses ferric oxide particles in a glue suspension that is poured onto the disk. Today read/write heads are actuated by a magnetic voice coil for quieter, more reliable, and, most importantly, faster operation. This technology is a vast improvement over the jerking of the mechanical band positioner used previously.

variables, nor can it be quantified in discrete levels. For instance, most people believe there are but two levels of hard disk performance—AT-standard and XT-standard. Those specifications are just guidelines. IBM requires that disk drives for the AT have an average access time—which is determined by how long it takes the mechanism to find any random byte of data on the disk—of less than 40 milliseconds. An XT-speed disk drive may take more than twice as long to find the same random byte. (The IBM PC-XT specification for

hard disk average access time is 85 milliseconds, although some of the equipment supplied by the company runs at 100 milliseconds.) Actual hard disk access times, however, stretch across a wide continuum, from less than 15 to as much as 150 milliseconds.

Although the oft-quoted average access time of a hard disk does indicate a general level of performance, such figures do not accurately or completely reflect the response of the disk system in actual use. Average access time is, for the most part, a

function of the disk drive alone, but the hard disks are just part of a complete system that also includes the disk controller and the software that controls the disk drive.

Moreover, average access time indicates only one aspect of hard disk speed. Once a byte or record is found on the disk, it must be transferred to the host computer. Another disk system specification, the data transfer rate, reflects how quickly information can shuttle between microprocessor and hard disk.

■ HARD DISKS

Access time is chiefly determined by mechanical factors in hard disk design and construction, specifically the type of head actuator and the number of platters used in the disk design. The head actuator is the actual moving force that positions the read/write heads over the exact area of the hard disk platter that contains the desired information. The faster the actuator can move the head, the faster an individual record can be located on the disk.

CLOSING THE LOOP The electromechanical systems that make up all hard disk head actuators can be grouped into two distinct types: open loop and closed loop. The most-common realizations of these design techniques are the band-stepper and servo-voice coil actuators.

Whether the "loop" is open or closed merely indicates whether direct feedback about the head position is used in controlling the actuator. An open-loop system gets no direct feedback; it moves the head and hopes that it gets to the right place.

The band-stepper mechanism uses a stepping motor, a special direct-current motor that turns in discrete increments in response to electrical pulses from the control electronics instead of spinning. The electronics of the band-stepper system sends out a given number of pulses and assumes the stepper motor rotates that number of steps. The band of the band-stepper is simply a thin strip of metal that couples the rotating shaft of the motor to the linear travel of the head. Each pulse thus moves the head across one track of the hard disk. The speed at which this form of actuator can operate is limited by the rate at which pulses can reliably be sent to the motor.

The closed-loop system gets a constant stream of information regarding the head position from the disk, so it always knows exactly where the head is. The system determines the location of the head by constantly reading from a special, dedicated platter—the "servo surface"—in the disk mechanism on which a special pattern that identifies each disk location is written.

The voice-coil mechanism operates like the voice coil in a loudspeaker—hence its name. A magnetic field is generated by a coil of wire (a solenoid) by the controlling electronics, and this field pulls the head mechanism against the force of a spring.

CRASHPROOFING YOUR HARD DISK

A hard disk requires almost no maintenance, but it's wise to take preventive measures to keep it in top-notch working order.

You need not worry about greasy rags and oil cans when it comes to taking care of and maintaining your hard disk drive. Because disk drives have so few moving parts, almost nothing in them can wear out—and whatever might wear out you can't do anything about.

However, if the information you have stored on your disk and the speed at which you can get at it are important to you, a few preventive measures will help you make sure that your hard disk is a reliable storage system and not a random disaster.

The first rule of disk maintenance is backup. Whenever you've done significant work on your PC or AT, you should back up the hard disk copy to another disk or a tape. Always back up before running maintenance software because mistakes or power failures during execution of these programs can have deadly effects on your data.

For a variety of reasons having to do with the magnetic-storage medium itself, individual data bits—and sometimes whole blocks of them—can go bad on your hard disk. Not that data strangely changes, but rather areas on the disk lose their storage abilities.

That disastrous transformation can change normal disk space into bad sectors. If you try to save data to that area—or, heaven forbid, should you already have something stored there—you will be unable to retrieve it.

Many mainframe and minicomputer disk systems actively monitor themselves and deallocate these newly formed bad sectors during normal operation, making the dangerous disk areas inaccessible so that the system does not try to use them.

DOS, however, does nothing about a decaying disk. Worse yet, even the FORMAT program can miss marking bad sectors and leave them available on your disk as traps for unwary data. You won't know that something is wrong until it is too late, and you've lost a block of data or a whole file.

You can prevent such surprises (but not eliminate the problem) by periodically testing your disk for bad sectors. Many disk drive manufacturers suggest that you use Norton Computing's Disk Test program, which warns of potentially dangerous disk areas and can deallocate them. Disk Test is better able to locate bad sectors than is the DOS FORMAT program, so after you run it you can be more certain about the quality of the available storage. To be safe, you should run Disk Test about once a month.

A BAD FAT If the worst possible disaster befalls your hard disk and you're greeted by an ominous message like "Bad File Allocation Table," don't throw away your disk. While such problems are fatal to your data, your disk might still be good. (Even with a bad FAT, you can recover information from your disk. However, if you keep regular backups, making the effort is not really worthwhile.)

Errant electrical pulses are often the cause of this problem. The solution, traumatic though it may be, is to start all over with a clean slate.

If possible, reformat your hard disk with IBM's Advanced Diagnostics or your disk maker's own low-level format program. Repartition it with FDISK and then run DOS's high-level FORMAT program (or whatever programs your

disk's maker supplies as substitutes). Your disk should then be as good—and as blank—as new.

Because of the manner in which DOS organizes data on disks, whenever a hard disk is used extensively and for long periods, files get broken into small, scattered pieces called clusters.

Although breaking data into clusters is good for DOS and helps it squeeze as much information as possible on a given disk, such scattered clusters impose two penalties. Whenever you try to access a file, your system must waste time collecting all the clusters. That operation slows down your disk. Furthermore, should you ever try to recover an inadvertently deleted file with an uneraser program, scattered clusters make success more difficult.

At least two programs are available to unscater clusters and make all of your disk files contiguous.

The shareware program *Disk Organizer* does such a good job on disks of up to 32 megabytes that its nominal price makes the long wait in getting the program (its author-cum-publisher mails out copies only about once a month) worthwhile.

Although more costly, the commercial program *Disk Optimizer* from Soft-Logic Solutions is more versatile and more widely available, particularly on an instant gratification basis.

Run either program about once a month when your system has enough free time (up to several hours) to devote to this function. And don't forget to back up all your files first. Remember, where hard disks are concerned, accidents inevitably happen at the worst possible moment.—Winn L. Rosch



FACT FILE

The Norton Utilities

Peter Norton
Computing
2210 Wilshire Blvd., #186
Santa Monica, CA 90403
(213) 826-8032
List Price: \$99.95

Requires: 128K RAM, DOS 2.0 or later.
In Short: DOS enhancement utilities, including very powerful file and directory recovery and many, many convenience features. Not copy protected.

CIRCLE 699 ON READER SERVICE CARD

Disk Optimizer

Soft-Logic Solutions
530 Chestnut St.
Manchester, NH 03101
(800) 272-9900

List Price: \$49.95
Requires: 128K RAM, DOS 2.0 or later.
In Short: A file cluster reorganizing system that also includes a program to evaluate disk cluster scattering, a file security system, and a byte-level editor. Copy protected (\$25 extra for non-copy-protected version).

CIRCLE 697 ON READER SERVICE CARD

Disk Organizer

Soft-GAMs Software
G. Allen Morris III
1411 Tenth Ave.
Oakland, CA 94606

List Price: Shareware, \$20 license fee.
Requires: Some free disk space, DOS 2.0 or later.

In Short: A file cluster reorganizing program that will optimize the placement of individual files to minimize disk drive head movement. *Disk Organizer* is shareware and can be downloaded from the PC Magazine Interactive Reader Service, (212) 696-0360. Not copy protected.

CIRCLE 698 ON READER SERVICE CARD

By varying the current in the coil, the head mechanism is drawn farther from its anchoring spring and the head moves across the disk.

The servo-voice coil system need not count out each step to the disk location it needs to travel to. It can quickly move to approximately the correct place and, in milliseconds, fine-tune its location based on the servo information.

For its better performance, the servo-voice coil system trades off the use of one side of a platter, reducing the need for more-complicated control electronics. In general, high-performance hard disks, such as those from Core International or Priam, use servo-voice coil actuators. Lower-performance disk drives, such as the standard unit in an IBM PC-XT, use the less-expensive band-stepper arrangement.

BUMPER PLATING The number of platters used by a disk drive also influences its average access time. The more platters a disk drive uses, the greater the probability that one of the heads associated with one of those platters will be above the random byte. On the other hand, more heads means a more complex and more massive head assembly, which tends to slow things down.

The number of platters exerts more of an influence on the capacity of the disk drive—the more surface a disk drive has for recording data, the more capacity it will have. To some extent, the magnetic material on the platters also influences disk drive capacity (and, in a minor way, speed). This magnetic material also influences the ruggedness of the drive.

The platters in hard disks are usually thin but inflexible aluminum disks that are covered with a material that can be readily magnetized—the magnetic medium. Traditionally, the platters have been coated with a ferric oxide compound—essentially fine grains of rust—that is coated over the aluminum substrate of the platter and held in place by a special binding material. The oxide coating is similar to the coating layered on magnetic tape like the common audiocassette, VCR tape, and floppy disk surfaces.

Because the coating process and the oxide compounds themselves have been

■ HARD DISKS

evolving for more than 40 years, it is a well-understood, familiar technology.

Thin-film magnetic media are a recent alternative to these traditional oxide coatings. As the name implies, a thin-film disk has a microscopically skinny layer of a pure metal, or mixture of metals, bound to its surface. These thin-films can be applied either by plating the platter or "sputtering" (a form of vapor plating) metal onto the disk.

Thin-film media hold several special advantages over oxide technology. The very thinness of thin-film media allows data to be packed more tightly onto the disk, and that means more megabytes per platter. Tracks and data are closer together, so the read/write head need not move as far between random bytes, fractionally improving disk performance.

One reason that thin-film can be so thin and support high recording densities is that as with chrome-plated automobile bumpers and faucets, plated and sputtered media require no binders to hold their magnetic layers in place. As with chrome plating, the thin-films on Winchester platters are genuinely hard—many times tougher than oxide coatings.

Because plated platters are harder than most read/write heads, they are less susceptible to some forms of ruinous head crashes. Typically, head crashes on oxide-coated platters harm the disk rather than the head—the head actually plows a small furrow in the soft oxide coating, uprooting data all along the way. On the other hand, the head merely bounces off most plated media.

Although among hard disk makers opinion is quite divided as to how tolerant or prone to crashes various media are, my practical experiences definitely favor thin-film media. I've had an oxide disk crash when I've gently moved a PC system unit while it was on. During one year, another oxide coated disk I constantly use has had two sectors separately go bad. None of the thin-film disks I've had have lost data, and I've never had one crash—despite a system unit tumbling to the floor while writing to the disk.

To increase the security of your data, better hard disks using either media type have a "park and lock" feature that withdraws the read/write head from the active

data area when the disk drive motor is shut down, minimizing the probability of damage to active data.

MAKING TRACKS No matter the type of magnetic media or style of head actuator used by a disk, the read/write head must stop its lateral motion across the disk whenever it reads or writes data. While it is stationary, the platter spins underneath it. Each time the platter completes one spin, the head traces a full circle across its surface. This circle is called a track.

Each head traces out a separate track across its associated platter. Because the combination of all the tracks traced out at a given head actuator position forms the outline of a solid cylinder, such a vertical

■ Thin-film media hold several special advantages over oxide technology.

stack of tracks is often termed exactly that: a cylinder. Typical PC hard disks have between 312 and 1,024 cylinders (or tracks per platter). The number is permanently determined by the number of steps made by the stepper motor or magnetic pattern on the servo surface (which you cannot alter) of the disk.

Most hard disk systems further divide each track into short arcs called sectors—usually 17 of them. Sectors are merely marked magnetically (using a low-level format program), and their number is somewhat arbitrary. It varies, for instance, when the disk is formatted for run length limited recording.

In the standard DOS configuration, each sector holds 512 bytes of data, but this, too, is only arbitrarily defined. Some software that extends the hard disk capacities accessible by DOS stretches sector size.

Ordinarily you won't have to tangle with such things as cylinders and sectors. DOS keeps track of all those details for you. However, when you attempt to match

a hard disk to your AT yourself, you'll have to have its number of cylinders and heads handy. Setting up your system for the wrong parameters can lead to baffling problems.

The order in which DOS reads the sectors on each track can have a large influence on the performance of a disk drive. Because most disk drives can handle information faster than their host computers can deal with it, the low-level format of the drive can be used to force the system to read one sector and then skip several sectors before reading the next, a process called sector interleaving. The number of skipped sectors is called the interleave factor. It is a function of the low-level format of the disk drive and not of the disk drive itself.

OTHER SPEED FACTORS Other hardware design factors can influence the speed at which information can be moved from a hard disk to the electronics of your computer, however. The ultimate data moving speed is controlled by the data transfer rate of the hard disk subsystem, although other considerations often limit the actual throughput of information to a much lower rate than this data transfer speed.

The primary controlling factor in data transfer rate is the type of interface used in connecting the disk drive to its host computer. Standards organizations recognize several hard disk interfaces and tightly define their interconnection specifications.

The most common interface standard in PC hard disk systems is ST506/412, which is used in IBM's PC-XT and PC AT systems. ST506 specifies a data transfer rate of 5 million bits per second (5 MHz). Newer interfaces, such as the Small Computer System Interface (SCSI—pronounced "scuzzy" by some, "sexy" by others) and the Enhanced Small Device Interface (ESDI), allow greater freedom in choice of data transfer rate. For instance, one ESDI standard specifies a transfer rate of 10 MHz.

Although such double-speed operation may be tempting, you'll need a high-performance computer to take full advantage of it. The XT (and PC) can't even keep up with the 5-MHz speed of ST506. Moreover, neither SCSI nor ESDI disk drives are able to plug into existing IBM PC-XT

or PC AT hard disk controllers.

As with the ST506 standard, the ESDI is a device-level interface. Its connections are fundamentally made directly to the device that's to be used, and it makes a good match into the PC environment. For instance, Compaq Corp. has chosen ESDI for its Deskpro 386 hard disk drives.

SCSI is a system-level interface, which means that it provides what is essentially its own expansion bus to plug into. SCSI may actually plug into another interface, like ESDI. In some ways that makes it redundant in the PC environment (do you really need two different expansion buses?). SCSI is also designed to operate best when shifting blocks of data around, and its performance suffered in some early systems. But proper implementations make SCSI more than a match for ST506.

Another influence on data transfer rate is the data coding scheme used on the disk. The chief means of data encoding is called modified frequency modulation, or MFM. A newer form of data encoding called run length limited (RLL) can squeeze data more densely into each hard disk track, resulting in greater speed and capacity. Today's most-favored RLL system—2,7 RLL—boosts both by 50 percent. Advanced RLL (ARLL or 3,9 RLL) can double the speed and capacity that a disk drive would have using MFM.

RLL encoding requires that a hard disk have wider than normal bandwidth in its control electronics to handle its higher data rate. Consequently, not all hard disks can handle RLL reliably. If you plan to explore RLL, which requires that you use a special RLL controller board instead of the standard controllers, be certain that the disk drive you choose is certified to use it.

With today's rapidly tumbling prices, adding a new hard disk—either replacing one of your PC's floppy disk drives or just filling a vacant drive slot in your AT—can be the most cost-effective productivity boost you can give to a personal computer. A little attention to the details of disk design and a little shopping are all you need to be sure that the product you choose is the perfect match for your system and your mass-storage needs.

Winn L. Rosch is a contributing editor of PC Magazine.

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HARD DISK HEAVYWEIGHTS

Just a few years ago, only the most optimistic or pessimistic of PC owners would have thought that disk drives over 100 megabytes in capacity would ever snuggle inside their computers. The optimists foresaw the days when the PC would take over the chores formerly consigned to minicomputers and mainframes and would let them take care of massive jobs in the privacy of their offices. The pessimists feared the workload and responsibilities of those possibilities would drop on their shoulders and desktops.

Big disks are no longer a matter of speculation. With almost alarming frequency, mass-storage makers are pushing the top end of their product lines well above the 100-megabyte mark. While once you might have considered greasing the sides of your disk drive slots to squeeze in a disk drive as large as 100 megabytes, today you can fill one slot of your AT with a 380-megabyte unit.

If you haven't had a hard disk for more than a couple of weeks—and consequently are not bumping up against its storage limit—you might wonder why anyone needs more than 100 million characters of storage. Working alone, an individual may or may not need that kind of storage. As soon as the disk resource is shared, however—for instance, in a network server or multi-user system—the disk space is always at a premium because each person

If you thought you couldn't possibly use over 100 megabytes of storage capacity in your hard disk, the prices, features, and quality of the products reviewed here just might cause you to reconsider.

■ HIGH-CAPACITY HARD DISKS

only gets a small slice of the total capacity. Even in single-user systems, mass storage requirements tend to expand to fill whatever disk is available—and then keep right on growing.

Although part of the blame for ever-expanding mass-storage needs can be laid on wastefulness in resource management—with scattered duplicate files and backups all over the disk—most of the time, increased capacity requirements are genuine. Once a computer system proves its usefulness, more and more jobs are consigned to it, each one making its own storage demands. Multiuser systems naturally attract more users; databases inevitably grow; files and records tend to pile up.

The only way to avoid—or at least postpone—a mass-storage shortfall is to invest in a truly large hard disk, one able to handle megabytes beyond your present or foreseeable needs. The disk drives in this heavyweight category easily take care of almost any such situation.

BIG DRIVES, BIG PROBLEMS Although these big disk drives are becoming almost commonplace as manufacturers get better at fitting more platters into each disk drive and squeezing tracks closer together, making that much mass storage useful inside a PC is not so simple. Neither PCs nor PC/MS-DOS were designed with capacities anywhere near 100 megabytes in mind, let alone beyond that. Both PC hardware and standard operating systems place arbitrary limits on the maximum amount of disk storage that can be used.

The primary limit is the 32-megabyte DOS addressing maximum. According to the DOS standard, the largest single disk drive that the operating system is willing to deal with is 32 megabytes—only enough space to map that much disk space is allowed in the standard DOS file allocation table (FAT).

DOS stores information on disk in allocation units called clusters, which in the normal scheme of things consist of four physical disk sectors that each hold 512 bytes. Individual files are assigned clusters through a mapping system in which one entry in the FAT allocates a cluster to a file. Because DOS devotes only a limited amount of disk area to the FAT, only a finite number of clusters can be mapped

ped—enough for 32 megabytes of 2,048-byte clusters.

Manufacturers have developed three principal schemes to sidestep the lack of FAT on their hard disks: slicing the disk into several "logical" disks, each with its own drive letter and 32-megabyte size limit; devoting more disk space to the FAT; and increasing the cluster size.

The first of these methods is termed *partitioning*. Although it is more frugal with disk space and generally the safest method because it requires no changes in the normal DOS disk setup, partitioning imposes its own penalties. For instance, all files must be smaller than 32 megabytes because DOS makes no provision for di-

■ Neither PCs nor PC/MS-DOS were designed with capacities anywhere near 100 megabytes in mind, let alone beyond that.

viding a single file among several disk drives or partitions (other than through the BACKUP and RESTORE programs).

Increasing the size of the FAT requires modifying the DOS programs themselves. While DOS, is amenable to such software surgery, complications are inevitable. Most applications expect to be able to run in a standard DOS environment. Although most programs have no problem adapting to more FAT because they never bother looking at it (letting DOS do all the dirty work), some disk maintenance utilities and file recovery programs may be sensitive to the size and arrangement of the FAT. Such software might not work with a modified version of DOS.

In addition, unforeseen consequences can arise at any time after DOS has been modified. Although as delivered by IBM (or Microsoft), DOS is thoroughly tested and generally free from bugs, after modification no guarantees exist. The change of

even a single byte may lead to unpredictable crashes at any time, particularly when such alterations are made without the benefit of the source code, as third-party modifications must be.

Clusters can be enlarged beyond 2,048 bytes by increasing the size of each of the four sectors or by using more than four clusters per sector. Sector size is a function of the low-level format of the disk and may be fixed by purely physical considerations such as data density and the speed of the spinning disk. The number of sectors assigned to each cluster is a function of DOS and can be easily modified. In fact, DOS versions after 3.0 make specific provisions for enlarged clusters.

Enlarging cluster size does not come free, however. No matter what the size of a file or subdirectory, the minimum disk space it can occupy is one cluster. Large files must occupy disk space equal to some multiple of the cluster size. Thus, on the average, every file and subdirectory will waste disk space equal to one-half the size of a cluster. If you store many files on a disk, you'll waste more space with larger clusters. The problem becomes less significant as file size increases because the waste becomes a smaller fraction of the space actually devoted to data storage.

Some manufacturers of huge hard disks allow you a choice of methods for breaking the 32-megabyte barrier. For instance, you could partition the disk into two volumes: one with 2,048-byte clusters for small files, and one with larger clusters for your 150-megabyte database.

Many disk makers also allow a more radical option to avoid the 32-megabyte limit: abandoning DOS altogether. Most multiuser operating systems do not burden you with such artificial boundaries. Be careful, however. Not all hard disks allow the use of non-DOS operating systems.

UNCOUNTABLE CYLINDERS Another roadblock to installing truly huge hard disks inside PCs is a limit of 1,024 on the number of disk cylinders that the computer can address. With small-capacity disk drives, that total is often so far beyond the actual needs of the system as to be inconsequential. But once capacities get sufficiently past the 100-megabyte mark, complications arise.

The problem is purely physical. When manufacturers boost disk capacities, their most straightforward design choice is simply to pile in another platter. But the 5¼-inch hard disk package imposes physical limits on the available space. Consequently, disk makers are forced to squeeze tracks and cylinders closer together to fit a greater number of them on each platter. Fortunately, such increased track and data densities are now practical with new thin-film disk media. Unfortunately, such densities have pushed the number of tracks per platter over 1,024 to 1,224 and beyond.

Disk drives with more than 1,024 cylinders run smack into three brick walls: the IBM BIOS firmware, the original-equipment WD1002 controller in the AT, and DOS.

While the DOS-imposed cylinder limit can be overcome relatively easily by patching the software (but with the same caveats as apply to breaking the 32-mega-byte addressing limit), the BIOS and controller difficulties are based in firmware. This means that parts of the system hardware must be revised or replaced.

The controller cylinder shortfall can be overcome simply by replacing the controller itself, a process that's as easy as adding or exchanging an expansion board. Disk drives with the newer ESDI and SCSI interfaces require you to replace the controller anyway, so this limit isn't too much of a bother for them.

For example, Storage Dimensions, a company that uses an ST506 disk drive with 1,224 cylinders, opts to replace the original Western Digital WD1002 controller for the AT with the newer WD1003, which has a higher cylinder limit. Moreover, because the WD1003 incorporates more modern and more reliable VLSI circuitry, it is a true upgrade. But replacing it also means tossing out an otherwise workable controller.

The BIOS change is tougher to deal with because the system BIOS determines the entire personality of the computer. Since the BIOS firmware is contained in ROM chips on the system board, thoughts of altering it may cause even experienced PC experimenters to shudder.

Yet Storage Dimensions does exactly that to break through the 1,024-cylinder limit. The company supplies an IBM-com-

HARD, FIXED, RIGID, WINCHESTER—WHAT'S IN A NAME?

No PC peripheral hides behind more nicknames than the ubiquitous high-speed-rotation, large-capacity disk-based magnetic random access storage subsystem. IBM calls these critters "fixed" disks. Elitist users may roll "Winchester drive" off their tongues. Some engineers speak of "rigid" disks. We prefer the term "hard" disk.

Our favored label is derived from the support for the magnetic recording surface used in the systems. Floppy disks use a flexible—hence "floppy"—support. Hard disks most often use a rigid aluminum support—hence the term used by engineers for these products, rigid disks. Hard disk says the same thing in one less syllable.

IBM calls them "fixed" disks to distinguish them from floppy disks, which are removable media. You cannot pull a fixed disk out of its drive—without needing to fix the drive.

The term "Winchester" has been used to describe these devices because the first of them used a head assembly developed at IBM's Winchester laboratory.

The name has nothing to do with either the cathedral or the rifle.

In truth, all of these terms may be wrong. Hard disks don't have to be rigid or hard—the 3M company has developed an interesting flexible sandwich medium. And, spinning at 3,600 rpm, they are not actually fixed. Moreover, the same hard-platter, fast-spinning technology has been applied to cartridge systems (removable fixed disks?). And "Winchester" is not always an accurate description because a growing number of these devices use a less massive head design termed "Whitney" technology.

If you run into any of these terms, it may be refreshing, if somewhat confusing, to know they all are probably an attempt to say the same thing. Certainly one of them could be better than the others, yet we can't give a definitive reason for our preferred practice of calling these things hard disks. We just thought you'd appreciate knowing that everyone, including us, could be wrong about what they call those whatchamacallits.

—Winn L. Rosch

patible BIOS in a set of two ROM chips. When installing its disk system, you pop out your IBM BIOS and plug in Storage Dimensions. The dilemma in doing this should be immediately apparent. New ROMs inevitably alter your official IBM machine into a mere compatible. After the change, some particularly picky programs may not work, and interpreted BASICA, as supplied with PC-DOS, will no longer run. In addition, IBM may not service the computer unless the original BIOS chips are replaced.

Moreover, replacing the BIOS in compatibles may lead to the loss of some of the special features, such as the built-in setup menu of the PC's Limited AT. And sometimes the chips might not work at all—as was the case with a Faraday board on which I tried to test them.

Ever since the introduction of the XT

and the PC with RAM capacity of 256K bytes on the system board, IBM has made provision for adding extra firmware to personal computer ROM memory. This additional firmware, generally used to contribute extra functions (such as the control of a hard disk or EGA display) or modify existing ROM code, also provides an opportunity for breaking the 1,024-cylinder limit. Four techniques for adding the necessary firmware code are used by the companies whose products are reviewed here.

The simplest approach is to include the necessary firmware inside the controller ROM so that no additions to your system, other than the controller, are necessary. Of course, this technique imposes the expense of replacing an entire controller card just to change a few bytes of code. However, when the controller must be replaced anyway—for instance, to take advantage of a

■ HIGH-CAPACITY HARD DISKS

more advanced interface—it is a valid solution.

Another method is to plug in additional (rather than replacement) ROM chips containing the special firmware. Core International uses this technique for its systems that do not use a Core-supplied disk controller. Core's ROMs simply plug into vacant sockets on your PC's system board in addition to its native ROMs.

Unfortunately, not all compatible computers have vacant ROM sockets, so Core also allows the code to be installed through software that's written on the hard disk itself in a special, inaccessible area. This code loads automatically during the boot-up process, modifying the restrictive part of the system BIOS.

A more unusual method is employed by Emerald Systems Corp. The new firmware is located in ROMs on an extra short expansion card that's plugged into your system along with the disk controller. The two-board approach avoids any difficulties with compatibles lacking ROM sockets and also allows the use of a standard hard disk controller.

BETTER THAN AVERAGE Besides being big, the disk drive systems investigated here are the cream of today's disk products. They use the latest technologies and, generally, are made or assembled in the United States.

They are among the fastest hard disks available, partly because their size requires it. With tests yielding average access times under 30 milliseconds—some under 20—for normal DOS operations and handling files shorter than 100K, these disk drives will put a factory-installed AT hard disk to shame.

Performance assessment shows that these big disk drives fall into two distinct classes: the ST506 interface drives—including the Alloy ID-160, IDEAssociates Diskit A120, Priam ID130, and Storage Dimensions AT 160F—which transfer data at 5 MHz; and the EDSI interface drives—the Core HC150, Emerald DOS 150-3000, and Emulex ATS-170 and ATS-380—which transfer data at 10 MHz. The difference between the two interfaces will show up dramatically when you regularly deal with huge files, those in the megabyte range.

Beyond these unifying factors, however, each of the manufacturers represented here goes in its own direction. Some elect to make their systems as easy as possible to install, even going so far as to abandon part of the available storage area. Others offer more customization abilities than any sane person may want to tangle with.

Emulex includes tape backup; a few others, such as Alloy, Core, and Emerald, offer matching backup systems as options.

All of these products are designed to add into the IBM PC AT, but they have differing levels of compatibility with computers from other manufacturers. Only Alloy, IDEAssociates, and Priam make use of the native AT hard disk controller. Only Emulex uses an 8-bit interface that would be compatible with an XT-class machine (although it would be a waste to install such a high-performance disk subsystem in a low-performance computer like that).

Because no two PC environments are the same, none of these systems can be rated as the ultimate hard disk for all seasons—although all come close to that ranking. Which to choose is mostly a matter of matching their individual features with the demands of your system today and your plans for the future.

ALLOY COMPUTER PRODUCTS INC.

Alloy ID-160

Alloy Computer Products may be best known for its tape backup and interchange systems, but the company also produces a variety of mini and microcomputer products, including internal and external hard disk systems for the PC and AT.

An internal hard disk subsystem, the Alloy ID-160 we received made an auspicious first appearance. It came with its mounting rails installed upside down, an unnecessary (for installation in an AT) black faceplate already installed, and its drive select jumper set as drive 0. Proper operation required resetting this jumper to drive 1, per the IBM standard.

Based on the 190-megabyte Maxtor XT-2190 disk drive, the Alloy ID-160 is a solid piece of hardware with eight 5¼-inch platted platters and an automatic head-parking mechanism. The 160 in the Al-



FACT FILE

Alloy ID-160

Alloy Computer Products Inc.
100 Pennsylvania Ave.
Framingham, MA 01701
(617) 875-6100

List Price: \$5,995

Requires: AT disk controller, DOS 3.0 or later.

In Short: A 125-Mbyte, high-speed (30-millisecond average access time) hard disk system that uses the standard ST506 interface, 5-MHz data transfer rate.

CIRCLE 67 ON READER SERVICE CARD

loy's model designation refers to an unfurled capacity bounded by the 1,024 cylinder limit. Alloy makes no effort at wringing every byte from the 1,224 cylinders of the Maxtor disk drive, opting for simplicity instead of capacity. After formatting, the useful capacity of this disk drive amounts to 125 megabytes.

The Maxtor disk drives used in this and several other systems reviewed here are unique in their vociferousness. Their voice coils seem more like refugees from a stereo system than part of a computer hard disk drive, and at times they make distinctly musical sounds. Although the sounds are unusual and at times obnoxiously loud, they are also easy to get used to, perhaps even comforting.

After finishing a completely ordinary hardware installation procedure, during which the disk drive is slid into place and connected to the standard IBM PC AT combined floppy-and-hard-disk controller, the AT SETUP program must be run to identify the ID-160 as drive type 9.

Once the host computer is booted from a floppy disk, the ID-160 is installed with its own software, called *IPF*. As the first step, *IPF* is used like *FDISK* to assign clusters to individual partitions. The factory defaults divide the disk into four equal parts, each of 31.87 megabytes, although you can define more or fewer partitions in the sizes that you prefer.

Partitions beyond the DOS limit of 32 megabytes are permitted but require running a program called *IPATCH* after the first partition is DOS-formatted. As its

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CIRCLE 527 ON READER SERVICE CARD

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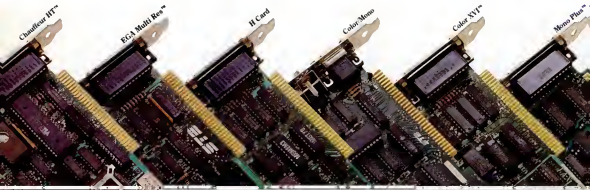
* STB includes drivers for Microsoft Windows with the resolutions of 640 x 480, 752 x 410 and 832 x 350.

* CGA software that is compatible with the IBM Enhanced Graphics Adapter.

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■ HIGH-CAPACITY HARD DISKS



The Alloy ID-160 hard disk drive system is based on the Maxtor XT-2190 disk drive. It has eight 5 1/4-inch plated platters and an automatic head-parking mechanism.

■ The Alloy ID-160 can be considered an excellent heavyweight- class storage device.

name implies, this program patches DOS to use a larger disk sector size.

Once you have set up your partition structure, *IPF* initializes the entire disk by performing a low-level format. The process proved to be rather time-consuming, requiring over an hour for all four partitions.

After you have completed this initialization, you reboot the system and DOS-format the first partition, afterward patching DOS if your configuration requires it. As with most systems, accessing partitions beyond the first requires copying a device driver to the boot partition.

The software installation process is ac-

tually easier than it sounds and should not present problems even to neophytes. Overall, the system performed well and demonstrated no difficulties or incompatibilities during testing. If you are afraid to venture too far from the IBM standard, the Alloy ID-160 can be considered an excellent heavyweight-class storage device.

CORE INTERNATIONAL

Core HC150

Core International has been in the personal computer business longer than there have been PCs. Its first systems were based on IBM's 5100 system, a pre-PC microcomputer. Since then, the company has grown to be a major supplier of PC mass-storage systems, backup systems, and (recently) its own computers.

The Core HC150, which yields about 150 megabytes of DOS-formatted storage, is one of a number of large disk drives currently offered by Core (the HC in the moniker stands for "High Capacity").

Although the Core HC150 appears to be based on a Control Data Model 94166-

182 disk drive and a Scientific Micro Systems OMTI 8000-series controller card, Core claims to have modified both to increase reliability and to squeeze the absolute utmost in speed from the system. At the very least, the company has eliminated the original manufacturer's logo by pasting (inelegantly at times) its own labels on components.

The ROM on the controller does, in fact, bear a Core copyright, and it does include a special firmware code that breaks through the 1,024-cylinder limit by making the CDC drive appear as if it had half its normal amount of cylinders and twice the heads—almost as if the drive were cut in half and stacked on top of itself.

Core will supply different models of the OMTI controller to substitute for either the standard IBM PC AT combined floppy-and-hard-disk controller or an OMTI card that will work in conjunction with it. When the OMTI card is used by itself, it will control both the Core disk drive (and a second one, if desired) and up to two floppy disk drives. The controller itself is a full-length expansion board that uses the AT 16-bit data bus but is low enough to fit into IBM's PC-XT Model 286.

The OMTI controller uses the ESDI interface at data transfer rates up to 10 MHz, giving the Core system a two-to-one advantage over systems equipped with the standard IBM-cum-Western Digital controller. To further enhance the rate at which contiguous sectors can be read, the Core HC150 is formatted with a 1-to-1 interleave.



FACT FILE

Core HC150

Core International
7171 N. Federal Hwy.
Boca Raton, FL 33431
(305) 997-6055

List Price: HC150 drive only, \$4,995. ESDI controller: with floppy controller, \$795; with no floppy section, \$695.

Requires: ESDI controller, DOS 3.0 or later.

In Short: A 150-Mbyte, high-speed hard disk system using a 10-MHz ESDI interface and 1-to-1 sector interleave.

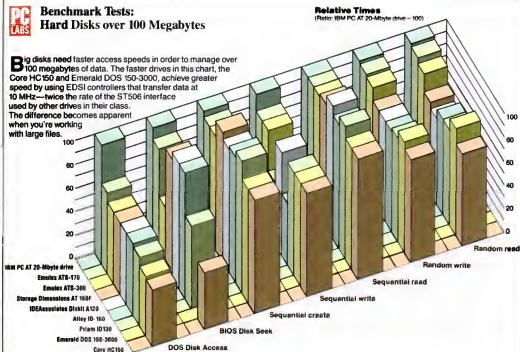
SOURCE: IBM ON READER SERVICE CARD

■ HIGH-CAPACITY HARD DISKS



Benchmark Tests: Hard Disks over 100 Megabytes

Big disks need faster access speeds in order to manage over 100 megabytes of data. The faster drives in this chart, the Core HC150 and Emerald DOS 150-3000, achieve greater speed by using EDSI controllers that transfer data at 10 MHz—twice the rate of the ST506 interface used by other drives in their class. The difference becomes apparent when you're working with large files.



Performance Times

(Times given in seconds except where noted.)

	DOS Disk Access (milliseconds)	BIOS Disk Seek (milliseconds)	File Access			
			Sequential create	Sequential write	Sequential read	Random write
IBM PC AT 20-Mbyte drive	43.50	37.35	9.39	20.36	8.73	17.30
Emulex AT5-170	29.79	33.98	8.92	17.36	8.79	18.91
Emulex AT5-380	26.48	18.62	8.99	17.40	8.83	18.18
Storage Dimensions AT 160F	26.24	36.89	10.13	10.12	9.02	14.66
IDE Associates DiskIt A120	26.96	39.42	9.63	17.03	9.56	14.48
Alloy ID-160	25.80	39.43	9.88	10.10	9.01	14.89
Priam ID130	24.98	26.66	10.25	17.19	9.56	15.25
Emerald DOS 150-3000	21.64	N/A	8.89	17.37	8.80	16.14
Core HC150	20.28	17.39	8.90	17.36	8.61	15.28

N/A—Not applicable; hardware call not supported by drive

The **DOS Disk Access** benchmark test measures the time it takes to do a random sector read using DOS. DOS buffers are set at 3 and the interleave factor is left at the drive's default setting. This test adds DOS's overhead to the BIOS and hardware times. The test program performs the sector read 1,000 times within the DOS disk partition. The average result is shown in milliseconds.

The **BIOS Disk Seek** benchmark test measures the time it takes to do a random seek using the disk's ROM BIOS. The test result includes minimal software overhead and may not parallel the manufacturer's claimed average access time. The test program performs 1,000 seeks. The average result is shown in milliseconds.

The **File Access** benchmark test measures the time it takes to sequentially create and write a 256K-byte data file using record lengths of 512 bytes and 4K bytes. The test program then performs a series of operations: a sequential read of the same file, a random write, and a random read.



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■ HIGH-CAPACITY HARD DISKS



The Core HC150 system is built around a Control Data Model 94166-182 disk drive. It is an excellent performer, fast, silent, and well integrated.

The Core-cum-Control Data drive proved to be an excellent performer in terms of average access time, too, turning in a tested time of under 18 milliseconds on some PC Labs benchmark tests. Despite the hefty servo-voice-coil actuator required to achieve that minuscule time, the Control Data drive runs amazingly quietly, and its seeks are almost inaudible above the din of the AT power supply.

Several cross-country mailings of the Control Data disk drive have proven its rugged construction. Although its disk platters are oxide-coated, the disk drive automatically parks and locks the head to minimize the potential for media (and data) damage. In addition, Core claims to have further "ruggedized" the disk drive through unspecified means.

The Core system was quite easy to install—pop out the standard IBM controller, slide in the Core, and plug in all the cables almost exactly where they went before. The disk drive slides into a vacant full-height disk drive bay. AT mounting rails were already installed on it.

Actual software installation, disk parti-

tioning, and formatting are all handled by Core programs. Included among them is Core's *Gigafile* software that not only allows the creation of disk partitions larger than the DOS 32-megabyte limit, but also permits you to gang multiple partitions or disk drives to function as one logical unit. The instructions are now divided among three separate booklets and appear to be a major step beyond the crude photocopied sheets the company formerly sent out with its multithousand-dollar systems.

Overall, the Core HC150 rates as an excellent AT disk drive subsystem. Although its performance is virtually indistinguishable from the other ESDI systems investigated here, it is better integrated than some of the others, requiring nothing more than a disk drive and controller.

EMERALD SYSTEMS CORP.

Emerald DOS 150-3000

Emerald Systems Corp. seems to specialize in making things big. At 150 megabytes, the Emerald DOS 150-3000 is actu-

ally the smallest disk drive in a series that steps up to 250 and 315 megabytes of total storage. Double-drive systems will cram up to 630 megabytes into an AT system unit.

From a component standpoint, the Emerald DOS 150-3000 system appears identical to the Core HC150. Both systems are based on the identical model of Control Data hard disk drive (94166-182), and both systems use the same series of Scientific Micro Systems OMTI 8000-series controllers for their ESDI interface. But from a basis of physical commonality, both the systems and companies diverge philosophically.

Instead of hiding behind glue-on labels, Emerald acknowledges itself as a systems house that integrates the components that other companies manufacture to create end-user systems. While Emerald writes its own software, the company makes no claim to modifying hardware—in the belief that the original manufacturers know best. To create a top-performing system, Emerald selects top-performing components.

The Scientific Micro Systems OMTI controllers that are supplied with all of the Emerald systems have built-in floppy-disk controllers. As shipped, however, this feature is defeated by a jumper, and the Emerald system relies on the AT's original Western Digital controller card for floppy disk operations. However, Emerald also supplies instructions for activating the floppy disk section should you decide to toss out your AT's native controller. Because the trend among AT-compatible manufacturers is to include the floppy-disk



FACT FILE

Emerald DOS 150-3000

Emerald Systems Corp.

4757 Morena Blvd.

San Diego, CA 92117

(619) 270-1994

List Price: \$4,995

Requires: DOS 3.2.

In Short: A fast, 150-Mbyte ESDI-based hard disk subsystem that uses a 10-MHz data transfer rate and 1-to-1 sector interleave.

CIRCLE 477 ON READER SERVICE CARD

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■ HIGH-CAPACITY HARD DISKS



Emerald bases its DOS 150-3000 hard disk drive on the same Control Data drive that Core uses. Emerald makes no hardware modifications, however, choosing to add only its own software.

controller on the system board, this seems to be a safe strategy.

To break the 1,024-cylinder limit, Emerald supplies special ROM firmware in an unusual manner. The code is contained in a chip on an additional 5-inch-long, 8-bit interface board that plugs into any free expansion socket inside the host AT. No connection is made between this board and the rest of the Emerald system except through the PC bus.

As with the Core system, the Control Data disk used by Emerald achieves a low average access time through use of a high-speed servo-voice-coil head actuator. For fast sequential access, the Emerald system takes advantage of the 10-MHz ESDI data transfer rate and a 1-to-1 interleave on the disk. The reliability of the oxide-coated disk is ensured by an automatic park-and-lock mechanism.

No precise average access time could be determined for the Emerald disk because its operating firmware proved incompatible with the PC Labs benchmark tests. However, when accessing data randomly through DOS, the Emerald system acquitted itself with a performance less

than one-half percent slower than that of the Core disk drive.

Hardware installation is straightforward and involves no more than sliding in the drive (supplied with AT mounting rails in place), dropping the two expansion cards into sockets, and plugging the disk drive into the controller.

Emerald supplies its own installation software to replace IBM's FDISK and FORMAT, as well as offering procedures that allow partitioning the 150 megabytes of disk into several logical drives (each with its own DOS drive letter assignment) or combining several drives into a single logical unit. In addition, the Emerald software breaks the DOS 32-megabyte barrier and allows a maximum single physical or logical drive volume of up to one gigabyte.

The Emerald installation procedure can be accomplished by issuing one command to DOS and making a couple of menu selections. It's fast because the big disk is supplied with its low-level format already in place. However, the Emerald system proved unusual in that the hard disk was not recognized after installation when the host computer was booted from a floppy

disk. It seems to require booting from hard disk for proper operation.

Besides that peculiar feature, the only disadvantage to the Emerald system is that it swallows two expansion slots. Its primary advantage is the speed achieved by its ESDI interface.

EMULEX CORP.

Emulex ATS-170 Emulex ATS-380

Emulex Corp. is one of those rare companies that dabble in both the IBM and DEC markets, making peripherals for the small computers of both companies. That the company can field successful products in the tough DEC marketplace is a tribute to its engineering expertise—as this pair of mass storage subsystems also demonstrates.

In fact, the Emulex ATS-170 and ATS-380 may force changes in some of the beliefs widely held in the PC hard disk industry. According to common lore, 8-bit interfaces and double-decking expansion buses individually slow down data speeds.



FACT FILE

Emulex ATS-170

Emulex Corp.
3545 Harbor Blvd.
Costa Mesa, CA 92626
(714) 662-5600

List Price: \$3,840

Requires: DOS 3.0 or later.

In Short: A combination 142-Mbyte (formatted) hard disk and 60-Mbyte cartridge tape backup system that uses both SCSI and ESDI interfaces but achieves very fast speeds. It wins Editor's Choice.

CIRCLE #76 ON READER SERVICE CARD

Emulex ATS-380

Emulex Corp.
3545 Harbor Blvd.
Costa Mesa, CA 92626
(714) 662-5600

List Price: \$7,105

Requires: DOS 3.0 or later.

In Short: A combination 310-Mbyte (formatted) hard disk and 60-Mbyte cartridge tape backup system that uses both SCSI and ESDI interfaces but is able to produce some very fast speeds.

CIRCLE #77 ON READER SERVICE CARD



HOW TO RUN A HARD DISK SYSTEM WITHOUT BACKUP.

Crossing your fingers is great when you're telling your mother-in-law you'd love to have her visit for a month. But, you are pressing your luck when you run your computer system without backup protection.

Crossed fingers won't help when a crash wipes out your data and you have to spend hour after hour trying to retrieve what has been lost, recreate what has been forgotten or re-enter what is gone.

But, a Cipher 5400 tape backup system can offer dependable security for that important data. Designed for today's high capacity disks systems on the IBM PC XT, AT and compatibles, the Cipher 5400 is available as a

stand alone, self powered unit offering 60 megabytes of fast backup and compatibility with such networks as Novell. The 5400 is completely read/write compatible with IBM's 6157 tape backup system. And, Cipher backs it with a two-year warranty and six-month warranty exchange program.*

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So, why not uncross your fingers and use one to dial 1-800-843-3751, Ext. 9; or within California, 1-800-722-0670, Ext. 9, for more information about the Cipher 5400 backup system.



CIPHER 5400 TAPE BACKUP SYSTEM.

cipher

* If your 5400 fails to operate within the first six months of use, Cipher will replace it. IBM PC XT, AT and IBM 6157 are trademarks of IBM Corporation. Cipher is a Registered Trademark of Cipher Data Products, Inc.

CIRCLE 232 ON READER SERVICE CARD

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The TimeWand



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Scan Quantity



Transfer Scan Data



Edit Scan Data



Develop Data Reports

Bar Codes, Computing, and the TimeWand... a Closer Look.

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TimeWand (2K version) - \$198
Recharger - \$149
TimeWand Communication Software (IBM) - \$299

Software available for the Macintosh, Apple // family, and Tandy (Model 100 and 200).



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TRICKS WITH BUFFERS AND SECTORS

If you want to wring all the performance possible out of your hard disk drive, you should try experimenting with two of the more mysterious operating parameters of your system: the sector interleave and the number of disk buffers. Set these aspects of your system to their optimal values, and your hard disk performance can significantly improve.

The sector interleave of your hard disk is established when the disk drive is low-level-formatted. It determines the subsequent physical arrangement of data on the disk.

In most disk systems, digital information is arranged on the surface of the platters in a specific, though arbitrary, pattern. The disk surface is divided into tracks (often termed "cylinders"), that are defined by the area that is scanned under an unmoving read/write head. Tracks are arranged as concentric circles spreading outward from the hub at the center of the disk.

Each disk track is subdivided into small arcs called sectors that, in the usual PC scheme of things, each hold 512 bytes of data. The two types of sectors are often referred to as physical sectors and logical sectors.

Physical sectors correspond directly to the arcs in each disk track. They are arranged sequentially and are contiguous to one another; typically, they are numbered 1 through 17.

Logical sector numbers refer to the manner in which the disk controller looks at the sectors. Because the data is read from the disk at the high rate fixed by the interface and many computers cannot absorb information at that rate, the information

is read from the disk one sector at a time, with pauses in between. The pauses correspond to the discrete amount of time required to allow one or more sectors to pass under the disk drive head unread. For instance, the control electronics might make the system read every other sector to cut in half the speed at which information piles up. The numbers identifying logical sectors are applied in the order in which they are read.

The sector interleave of the hard disk refers to how many physical sectors pass under the read/write head for every logical sector that is read or written. In the case of a system in which every other sector is skipped, two physical sectors must pass under the head for each logical sector. This system is described as having a sector interleave of 2-to-1 or, sometimes, simply as 2. IBM uses a sector interleave of 6 for the XT system. The faster AT uses a sector interleave of 3.

You can alter the sector interleave of your system if you have access to a low-level-formatting program such as IBM's *Advanced Diagnostics* or the software that accompanies many add-in hard disks. Usually you are given a choice of the interleave value to use. You may want to experiment with different values to find the one that's best for you—remembering, of course, that when you low-level-format a disk you destroy all the data written on it.

For stock hard disks, IBM's figures don't appear to be too far off, although in some systems, interleaves as low as 2-or 1-to-1 offer some improvement. If you have the time and like to tinker, it's worth a try.

Buffers are blocks of your PC's electronic random access memory in which the data read from your hard disk can be temporarily stored. With part of your system's RAM used as a buffer, information can be read from your hard disk very quickly and doled out more slowly at the rate your computer can handle it.

Although buffering does not change the speed at which the original disk read is made, subsequent reads may be made at RAM speed without the mechanical delays imposed by moving the head or spinning the disk, yielding a dramatic performance improvement.

Such buffering schemes are wonderfully effective when contiguous records are being read but they offer little benefit—and sometimes impose a slight penalty—when records are accessed completely at random.

DOS has a built-in disk-buffering system that is controlled by the **BUFFERS**= statement in your system's **CONFIG.SYS** file. Without the **BUFFERS** statement, your system defaults to two or three sectors of buffering (depending on the DOS version you use). This default value may be the worst possible one that you can use.

You'll want to experiment with different values up to 99, the DOS limit. Because larger numbers do not necessarily guarantee better performance and because each buffer consumes roughly 528 bytes of system RAM, you'll probably not want to go the whole hog.

In most cases a value of 15 to 20 buffers is the best compromise. All testing for this series of articles was performed with **BUFFERS=20**. —**Wm L. Rusch**

Combined, they should make data crawl—or so says conventional wisdom.

Yet while both of these Emulex systems feature those supposedly speed-robbing designs, they play second-fiddle to no one when it comes to disk speed. They are among the fastest AT disk drives available anywhere.

These two systems differ only in the

standard disk drive. The ATS-170's megabyte configuration uses a Micropolis Model 1355 drive that yields about 142 megabytes formatted (170 unformatted); the ATS-380, uses a Maxtor EXT-4380 that gives about 310 formatted megabytes (380 unformatted). Beyond that, they are identical and use the same host adapter, controller, software, and tape backup system.

The Emulex system uses both the SCSI and ESDI interfaces. A host adapter—a full-length XT-height expansion board—converts the 8-bit PC bus into the SCSI interface, which is in turn connected to a 5½- by 7½-inch controller card that provides the ESDI interface used by the high-capacity disk drive units.

Probably because of its minicomputer

■ HIGH-CAPACITY HARD DISKS



The Emulex ATS-170 and ATS-380 hard disk systems offer excellent performance. High performance and a low price tag of \$3,840 make the ATS-170 an Editor's Choice. The ATS-170 is based on a Micropolis disk drive and the ATS-380 on the Maxtor EXT-4380, which gives 310 formatted megabytes. Installation may be difficult, but in this case it is worth the trouble.

heritage, Emulex recognizes the importance of backing up hard disk data, particularly in such a huge system. Consequently, these disk systems include a Kennedy 1/4-inch cartridge backup system that uses standard DC600A cartridges.

The tape drive partly explains the use of the SCSI interface. The Kennedy unit plugs directly into the SCSI bus.

The only penalty imposed by the two-part hardware interface is installation time. It gives you an additional board to screw into your computer at the bottom of a drive slot. Emulex includes detailed instructions for this installation and supplies all necessary cables cut exactly to length. The hard disk drive fits only in the AT's internal disk drive bay; the tape drive, only under the A: floppy disk drive.

The biggest installation problem is slinging those cables around. It can be quite confusing even with the aid of the well-illustrated instructions. But once the hour or so of installation is over, the payoff is a top-notch mass-storage system—second to none but comparable to several.

Software installation requires running several programs and installing a device driver in the host system's CONFIG.SYS file, but it presents no unusual difficulties. The only bothersome part is low-level-formatting the hard disk drive (although Emulex supplies the disk drive already formatted, the instructions recommend that you do it again to ensure against shipping damage).

If you accept all the recommended defaults for the first format, you'll verify each sector eight times. That seems like a really good idea if you want to be sure of the quality of your storage system, but you'll end up writing off the rest of the day. The process takes hours to perform.

Once that's done, you partition the disk drive and DOS-format it with the Emulex software. If you want, you can break the big disk drive into multiple logical drives or blast through the DOS 32-megabyte limit and give the whole thing one drive letter. You can elect to install system files on the Emulex disk drive so that it will boot your system.

Because the Micropolis drive uses only 1,022 cylinders, it has no worries about addressing limits. The Emulex ROM evidently takes care of the 1,222 cylinders of the Maxtor.

Emulex also supplies the necessary software for operating the tape backup system, which has programs for backing up and restoring individual files, groups of files, whole partitions, and disks.

Despite the 8-bit host connection and doubling up of interfaces, the Emulex systems kept up with the best-performing, full 16-bit, all ESDI drive systems. In large files their performance matched both the Core and Emerald systems. Only on random access did either system flag because of the slower response of the Micropolis and Maxtor drives, as compared with the Control Data.

If you're not afraid of the complex hardware installation, either Emulex system can be an effective means of adding more than 100 megabytes to your system.

IDEASSOCIATES INC. IDEAssociates Diskit A120

The idea behind the IDEAssociates Diskit A120 is packaging an easy-to-install add-in hard disk system backed by a strong support system as an alternative to the take-your-chances raw drive market. Although IDEAssociates' smaller drives achieve this result commendably, this—the largest drive in the series at about

PC MAZON FACT FILE

IDEAssociates Diskit A120
IDEAssociates Inc.
35 Dunham Rd.
Billerica, MA 01821
(617) 663-6878

List Price: \$7,995
Requires: AT disk controller, DOS 3.0 or later.

In Short: A 120-Mbyte (formatted) hard disk subsystem that makes use of the existing AT controller and includes complex installation and customization software.

CIRCLE 17 ON READER SERVICE CARD

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CIRCLE 283 ON READER SERVICE CARD

■ HIGH-CAPACITY HARD DISKS



The IDEAssociates Diskit A120 integrates a Maxtor XT-1140 140-megabyte drive with proprietary initialization software. The drive works fine, but the software needs work.

120 megabytes (formatted)—violates one of IDEAssociates' own design rules: its software is probably too complex for inexperienced users.

I've tangled with the IDEAssociates software many times before. When everything is right with a system, installation can go smoothly. But should the slightest problem crop up, the process can reduce you to tears. With this system, everything went awry.

At first glance, the IDEAssociates Diskit A120 is a straightforward system—the whole kit is nothing more than a Maxtor XT-1140 140-megabyte (unformatted) hard disk, a cable, a software disk, and instructions. Designed for installation in an AT only, it makes use of your existing combined hard-and-floppy disk controller.

Hardware installation is a breeze. Just slide the disk drive into a free drive bay—AT-style mounting rails are already screwed to the disk drive—plug in the two data cables and a power cable, and button things back up. Turn on your AT and tell it you've got drive type number 9. Because the Maxtor drive uses only 1,024 cylinder

ders, no BIOS change is required.

Software is another matter. IDEAssociates supplies programs for both initializing (low-level-formatting) the disk drive and slicing and dicing its immense capacity up to your heart's content—or breaking the DOS 32-megabyte limit and putting all your bytes in one basket. If your disk drive is initialized, you should have no problem configuring it to meet your needs.

However, if your disk drive arrives unformatted, as did the evaluation unit, or if you want to vary its most intimate operating parameters, you're in for an initialization adventure so Byzantine that it makes a government bureaucracy look well organized and lucid.

In truth, the potential of the IDEAssociates program package is immense. You can change interleaving, sector size, and whatever other drive parameters you think will give you better performance than the stock configuration. But if your experiences with it are like mine, you'll also feel more twisted than if you got stuck in an automatic pretzel-making machine.

Put simply, this software needs work.

Other programs achieve the same results without the confusion.

Once—and if—you get this big IDEAssociates Diskit A120 working, you'll have a quick-performing system that is limited only by the standard IBM ST506 disk interface. The Maxtor drive runs rings around the stock AT unit, although it can't quite keep up to the Priam (also reviewed).

If you like a good challenge, try this disk drive. If you can't pass this product up, let your dealer set it up.

PRIAM SYSTEMS DIVISION

Priam ID130

Priam Systems Division, the only company among those whose products are examined here that actually manufactures its own disk drives, has taken aim at the AT market with the idea that the world needs an easy-to-install, moderately priced, high-performance alternative to IBM's standard AT disk drives. The Innerspace series of drives, of which the Priam ID130 rates the largest, at 130 megabytes (formatted), succeeds admirably at achieving that end.

Hardware installation of the Priam ID130 is like that of any other hard disk—slide it in and match three cables to the appropriate connectors on the disk drive. Unlike other systems, the Priam won't give you worries about switches or jumpers. There aren't any. Your only worry is the installation software.



FACT FILE

Priam ID130

Priam Systems Division
3052 Orchard Dr.
San Jose, CA 95134
(408) 946-4600

List Price: \$3,598

Requires: AT disk controller, DOS 3.0 or later (PC DOS 3.1 or 3.2 for disk partitions over 32 megabytes).

In Short: A 130-Mbyte (formatted) AT hard disk system designed for ease of use and installation that supports PC-DOS 3.1 or 3.2 partitions up to the full disk in size.

CIRCLE 673 ON READER SERVICE CARD

The Fast Way To Keep Your Hard Disk Fast



Personal System/2
Compatible

"Vopt is something of a miracle. It performs its disk reorganization chores in seconds, instead of the minutes and even hours some other utilities can take. A sexy symbolic display shows the files being moved around on the disk, and informative tables provide useful information on disk utilization... also includes several useful utilities to check floppy disk speed, report hard disk access times, speed up screen writes, and more. ... a bargain. Vopt is fast, safe, effective, and even fun to use. What more could you want?"



Glenn Hart, PC Magazine
May 12, 1987, Page 36.

Vopt organizes your hard disk files into contiguous areas of your disk. Fast.

YOU NEED IT because your disk can access contiguous files easier and faster than the fragmented files DOS creates. DOS writes pieces of files in no particular order on your disk, wherever it can find a space big enough for the current fragment. As you write and rewrite records, the available spaces get smaller and the pieces of your files become increasingly scattered.

When files are scattered over the disk surfaces, it takes longer to gather up the pieces, because locating them on different areas of the disk surface involves mechanical motion. To find a particular piece of your file, even the next sequential record, your disk may have to reposition its Read/Write heads or wait out another rotation.

That's why your applications run slower on a disk which has been in use for a while than on a new disk. It's just working harder to find your data.

The cure is to reorganize the disk contents into contiguous clusters so finding them is effortless.

Unfortunately, disk organization is like housekeeping: it's no sooner done than DOS starts scattering file fragments again, your disk gets slower, and you have to organize it all over again. You need to organize *frequently* to keep file fragmentation in check.

There are several ways to get your files in order, but most of them take too long. Why spend more time organizing than you'll save in processing?

Vopt is the fast cure for a slowing hard disk—so fast you can run it in seconds from your AUTOEXEC. BAT file. Your drive will run like new!

EXTRA! When you get **Vopt**, you get more—a tidy collection of useful system utilities.

Vmap pictures your hard disk storage utilization, handy for seeing fragmentation. **Vopt's CHKDSK** can handle partitions much larger than DOS's skimpy 33 megabytes, as well as bigger sectors and clusters. If your disk has unmarked bad clusters, **Vmarkbad** will find them for you. **Vseek** graphically displays hard disk seek times over the full range of cylinders on your drive.

For your diskettes, **Vspeed** will check your timing margins and **Vrd** will locate surface defects on formatted diskettes.

We've also included **Vprtc**, a tiny resident program to speed up PrtSc operation, **Vbr** to give you the size, name, and interrupts held by all memory-resident programs loaded, and **Vbench**, timing benchmarks of your system against standard system times.

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System requirements: IBM PC-AT, PC-XT,
Personal System/2 or compatible, with
512K RAM.

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GOLDEN BOW SYSTEMS

2870 Fifth Ave, Suite 201

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HARD DISK CONTROLLERS

An examination of an overlooked component.

A hard disk is only part of a mass-storage system. No disk drive can accomplish its intended purpose without the aid of that oft-forgotten electronic component, the disk controller. Both interpreter and commander, the controller converts the data-oriented demands of your computer system into the special instructions that the disk drive needs to physically find each byte that it remembers.

Somewhere in every disk system lurks a controller hard at work. Although sometimes combined into the disk drive unit itself (as with many of today's miniature hard disk cards), most often the controller is a separate component that fits into an expansion slot of its host PC.

When you plan on adding a hard disk to a PC or hard-diskless XT, you'll need to get a controller to go with the drive. Most ATs are already equipped with hard disk controllers as part of their combined hard-and-floppy-disk controller card. Occasionally, however, you may find that you want or need to get a special controller for an AT, too.

In past years when disk drives were invariably bought from systems houses, the controller accompanied the disk drive. Although you had no choice about what controller you got, you could usually be sure it that worked with the disk drive you bought.

When you buy a bare hard disk drive and a separate controller, you may not be so lucky. To operate properly, the controller needs to know certain of the parameters used by the hard disk that it is to run. With many XT-style controllers,

this information was put into ROM firmware, something the average PC user may have a difficult time accomplishing without investing a thousand dollars in a PROM burner (to write the information inside a microchip) and a 5-year education in engineering.

However, a new generation of XT-style controllers now comes complete with support software that puts the necessary disk operating code on the hard disk itself, allowing almost anyone to play the mix-and-match game with such a controller and almost any hard disk drive. Scientific Micro Systems' *OMTidisk* program is one example.

AT owners face less of a problem than XT owners because many disk drive parameters can be controlled directly through the IBM PC AT system setup program. Alternatively, Storage Dimensions' *SpeedStor* program will aid you in sending all the right disk drive setup information to the controller.

All controllers are not created equal. They vary by their host interfaces, drive interfaces, and data encoding methods.

Of these, the host interface is the most rudimentary difference. Some controllers use 8-bit interfaces, enabling them to plug into PCs, XTs, and ATs—although they are not usually recommended for use in 16-bit bus systems. Controllers with 16-bit host interface buses work in AT-style computers, including the PC-XT Model 286 if the controller card will physically fit the smaller chassis.

Three chief drive interfaces are currently in use: ST506/412, SCSI, and ESDI. They differ in many ways: speed,

bus structure, and integration level. Your chief concern in choosing a controller for a given disk drive is to make sure that the controller interface matches that of the disk drive.

The data coding method used by a controller determines what patterns of magnetic pulses on the disk represent the data to be stored. More-advanced data coding schemes can squeeze more information on a given disk and move that information between the disk drive and the host computer faster.

Until recently, all hard disk controllers made for personal computers used modified frequency modulation (MFM) data coding, sometimes called double-density recording.

Last year a technique borrowed from IBM mainframes called 2,7 run length limited (RLL) began to appear in personal computer hard disk controllers. The 2,7 RLL system packs data 50 percent tighter and moves it back and forth 50 percent faster.

Early this year another run-length-limited data coding scheme was adapted to PCs by Systems and Software, under the brand name Perstor. Called 3,9 RLL, Advanced RLL, or ARLL, this system doubles disk capacity over MFM and doubles the data transfer rate.

The important thing to remember about these advanced data coding schemes is that, in general, they require a hard disk drive of higher overall quality—one that has been certified to use RLL. Most newer hard disk drive units meet the more stringent standards required by RLL.—Winn L. Rosch

That's no trouble, either. Once you've got your AT screwed back together, the installation process requires no software expertise. You merely boot up and run Priam's installation routine. You don't even need to bother with the AT's setup program. The Priam program takes care of that for you.

However, the Priam program does some mysterious things during the installation. It tells you little of what's going on and displays only cryptic messages on the screen. You are required to type in a few installation choices: do you want your new Priam disk drive to be the first or second in your system, or do you want to divide the

big disk into a number of DOS-size volumes and make the big disk act as exactly that—one big disk—without dealing with the DOS 32-megabyte addressing limit?

Being required to make those choices means that you're stuck with watching over the rather dull installation procedure, but at least it's quick—about 5 minutes.

Peachtree Complete Accounting for Just \$199

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A. We've reduced our costs without reducing product features. Peachtree Complete has been repackaged into one set that includes more thorough and better organized user instructions. We've also streamlined order processing and reduced overhead. It is faster and easier to buy our product.

Peachtree has long been the first name in accounting software, so we've had time to completely amortize our original development costs plus make over 100 major additions. These enhancements include multi-company capability, menu driven installation and removal of copy protection. Consequently, you're getting a proven product at a better price.

We also "unbundled" support (so you only pay for what you need when calling our toll-free technical support hotline) and established a network of local dealers to serve as Independent Peachtree Support Centers.

Q. What does Peachtree Complete include?

A. 1. Eight Integrated Software Modules:

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2. An **Installation Guide** to lead you step by step through our simple installation procedure.

3. An **Accounting Primer**, written for Peachtree users by an industry expert, to explain accounting concepts.

4. **Tutorials** on each module with sample data to make learning easier.

5. A complete **Reference Library** with detailed instructions in plain English on all software functions.

Q. Is Peachtree Complete really the same product that used to sell for \$600 per module?

A. Peachtree Complete is basically the same accounting system that both Peachtree and IBM sold for about \$5,000 but with substantial improvements in function and presentation.

With more than 150,000 users to its credit, Peachtree Complete has been the **PC World Class Winner** in its category for two of the last three years.

Q. What's the difference between Peachtree Complete and the \$69.95 systems?

A. Peachtree's system is called Complete because it contains the eight most needed accounting packages (including payroll) and all reference materials for one price. Remember, it was designed as a \$4,800

accounting software system.

The \$69.95 systems, on the other hand, are incomplete. They were designed to sell for \$69.95 and require the purchase of additional modules to be comparable—payroll, \$49.95 more; tutorials, \$19.95 each; etc. Everything is a la carte.

Q. How soon will I outgrow the system?

A. Peachtree Complete handles revenues up to \$21,000,000, so only the largest companies will outgrow the system. The ability to process data for an unlimited number of companies is one of the system's biggest selling points.

An optional multi-user module soon to be available allows Peachtree Complete to be installed in a Local Area Network. And Peachtree Data Query, for just \$199, lets you quickly transfer your accounting data

to many popular spreadsheets and databases, as well as produce custom reports.

Q. What if I'm not satisfied with Peachtree Complete?

A. When you purchase Peachtree Complete directly from Peachtree Software, you're protected with

45-Day Money-Back Guarantee (an option even the most expensive accounting products don't offer).

If you're not satisfied, simply return the complete product in saleable condition within 30 days and your purchase price will be promptly refunded.

InfoWorld Report Card

"Superb value, easy to use, good

manuals...We rate Peachtree's Complete Business Accounting System an excellent value."

—Richard Morochove, *InfoWorld* Review Board.

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CIRCLE 538 ON READER SERVICE CARD

■ HIGH-CAPACITY HARD DISKS



The Priam ID130 is the largest of Priam's Innerspace disk drive series, offering 130 formatted megabytes. Installation is a breeze, and the drive's performance puts it among the best tested.

When you're done, you'll discover that you don't even have to bother with FDISK and FORMAT. Thus the Priam is perfect for those who don't like to dip into DOS any more than they have to.

No low-level-formatting is necessary—it's done at the factory. The sector interleave is set at 2-to-1, but a low-level-formatting program is supplied for changing the interleave to anything that you want.

In addition, Priam supplies a complete set of utilities that allow you to take control (under the guidance of some good documentation) and set up your own disk partition structure (which, under PC-DOS 3.1 or later, can have individual partitions larger than 32 megabytes). These utilities include Priam's own versions of FDISK and FORMAT, since the Innerspace series of drives are not compatible with the standard DOS versions.

Priam supplies no means of coping with the 1,024-cylinder limit even though this disk drive uses 1,224 cylinders for an unformatted capacity of about 190 megabytes. The company philosophy favors simplicity rather than squeezing every last byte out of the disk drive.

The Priam ID130 disk drive appears to be well made, with solid construction and plated platters within. In fact, we accidentally discovered that the Priam ID130 was much more robust than even we had suspected.

Some lack of foresight had left a test AT equipped with the Priam ID130 perched dangerously close to the edge of the workbench during testing. At a particularly inopportune moment during the sector read test, I looked up just as the whole AT was on its way down, landing flat on its face in the short pile of a computer carpet with a sickening thud.

The test that was running at the time reported 20 errors but otherwise executed normally. When the test was repeated without the plunge, no errors were generated, and later tests of the disk drive revealed no apparent damage.

Compared with some brands of disk drive that gouge their platters when you slide them an inch or so across your desk—or even think about moving them—when their platters are spinning, the Priam ID130 rates as a hardy unit indeed.

It also proved to be fast—the faster of the two ST506 disk drives we tried in this

series of tests. Despite the wasted cylinders, the Priam ID130 rates as a sturdy choice for systems requiring more than 100 megabytes.

STORAGE DIMENSIONS

Storage Dimensions AT 160F

Like Emerald Systems Corp., Storage Dimensions makes no effort to hide the origins of the components it packages under its own name. That's understandable because it has chosen highly regarded products by reputable manufacturers to make a fast hard disk of about 160 megabytes (formatted) capacity.

The hard disk of the Storage Dimensions AT 160F is a Singapore-made Maxtor XT-2190 built around a fast but noisy high-performance servo-controlled rotary voice-coil head-positioning mechanism. To increase storage density and crashworthiness, the platters of the XT-2190 drive are plated with a thin-film metallic medium. The read/write head retracts from the active data area and locks when power is removed from the system.

In addition to the XT-2190 disk drive, Storage Dimensions also includes a pair of EPROM chips containing a new system BIOS and a disk controller designed to break the 1,024-cylinder barrier and allow access to all 1,224 cylinders of the drive.

The BIOS was written by Award Software, a company that has engineered the firmware of several well-known AT-compatible computers (including Multi-Tech). Although Storage Dimensions claims



FACT FILE

Storage Dimensions AT 160F

Storage Dimensions

14127 Capri Dr.

Los Gatos, CA 95030

(408) 370-3306

List Price: \$3,495

Requires: DOS 3.0 or later.

In Short: A 160-Mbyte (formatted) AT hard disk system consisting of hard disk, controller, and replacement BIOS that uses the ST506 interface.

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■ HIGH-CAPACITY HARD DISKS



The heart of the Storage Dimensions AT 160F is a Maxtor XT-2190 drive. It's an average performer but gains points for being straightforward and trouble-free.

these chips will work with most compatibles, they would not function when installed on a year-old Faraday system board. (If you don't mind wasting about 20 percent of the capacity of the disk drive, you can install it without the ROM exchange.)

The chips are rated to operate in ATs running at 8 MHz. If you have a faster computer, you'll need higher-speed EPROMs, which Storage Dimensions offers at a small price premium.

The replacement controller is a Western Digital WD1003, an updated version of the AT original-equipment model, the WD1002, that combines both floppy- and hard-disk control functions. As with the earlier controller, the WD1003 requires a full AT-height, full-length, 16-bit expansion slot and thus is not compatible with the PC-XT Model 286 or similar low-slung, full 16-bit computers.

Installing the controller and disk drive of the Storage Dimensions AT 160F system is no different from putting in any similar add-in peripherals. The controller replaces the one already in the host system, and the disk drive slides into any vacant full-height disk drive bay. The necessary

mounting rails for IBM PC ATs and for machines that use the same mounting hardware are already installed. Storage Dimensions also supplies all the necessary cables for connecting two hard disks and two floppy disk drives.

Even allowing for the extra effort and care required to replace the system BIOS, hardware installation of the AT 160F requires less than 15 minutes and should be easy if the instructions are followed.

Storage Dimensions furnishes its SpeedStor software for installation of the AT 160F. Although the process is elegantly simple—it automatically handles low-level and DOS-formatting, setting the proper drive-type value in CMOS configuration memory, and disk partitioning—it is time-consuming.

SpeedStor can slice the AT 160F into up to eight partitions of almost any size—within the capacity limits of the disk, of course—and substitutes for a number of DOS utilities, including FDISK and FORMAT.

Although only an average performer in the company of these high-performance products, compared with the standard AT hard disk the Storage Dimensions system

EDITOR'S CHOICE

• Emulex ATS-170

Choosing the best of these heavyweights depends upon the measure you choose. For utmost all-around speed, the Core HC150 and Emerald DOS 150-3000 top the list with their ESDI systems—but the Alloy ID-160 wins when using DOS alone to access short files and the Priam ID130 ranks number two among the ST506 units (besides being the easiest to install). The Storage Dimensions AT 160F is the capacity leader among the ST506 systems, while the ESDI drive suppliers all have products to push your AT to multiple hundreds of megabytes.

Our favorite selection is the Emulex ATS-170, however. Although it tops no individual category, its combination of features and price give it the overall lead.

We appreciate its fast, state-of-the-art ESDI drive connection, notwithstanding that the other ESDI drives are faster in average access time than its Micropolis drive.

The telling factor is its price. Not only does the Emulex ATS-170 list for \$1,100 less than its closest ESDI competition, but it's also less expensive than most simpler ST506 drives. On top of that, it even includes a tape backup system at no additional charge. Although we concede that with its double interface the ATS-170 is the most complex of the systems here and the most difficult to install, if you have patience and your time is worth less than \$1,000 per hour, you'll come out ahead with the ATS-170.

is lightning quick. If you don't mind the required ROM switch, it is a good choice for pushing the mass-storage capacity of your AT into the stratosphere. □

Winn L. Rosch is a contributing editor of PC Magazine.

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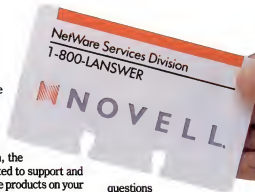
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CUT-RATE CONTENDERS

Cutthroat. No word better describes the competition in today's after-market hard disk drive arena. Whereas only a few years ago there were many system-integration companies packaging hard disks under their own label, there are now only a handful. Strong price competition from the computer mail-order houses and individual dealers has just about done them in.

What the system integrators offered were all of the things that IBM left out of the plain-jane PC, such as serial and parallel ports, a clock, adequate memory, and, of course, hard disk drives. The current crop of PC/XT/AT compatibles now features all but the hard disk as standard fare, and hard disks alone (particularly at discount prices) are not profitable enough for the system companies to justify supplying them.

The consumer is both a winner and a loser in the hard disk marketplace today. On the plus side are the very low prices offered by many mail-order companies. After all, the profit taken by the system integration companies has been eliminated, and the disk drives now go from manufacturer to retailer to consumer. You stand to save hundreds of dollars by buying a disk drive through the mail or corner computer store and installing it yourself.

Computer magazines are full of advertisements from mail-order houses that offer hard disk drives at remarkably low prices. Bargains abound, but knowing that you will be on your own when you buy one should make you cautious. Let us offer a few suggestions.

■ MAIL-ORDER HARD DISKS

The purpose of the reviews that follow is to help you make an informed purchase decision in this jungle of a market. We'll look at some of the performance aspects of a number of mail-order and dealer-supplied original equipment manufacturer (OEM) hard disk drives, and we'll provide information about features, construction quality, and operational characteristics. And it never hurts to ask a friend or fellow user group member with previous experience about a disk drive before you buy.

To add a measure of consistency to the reviews, all tests were conducted on an 8-MHz PC's Limited AT equipped with a Western Digital combination hard disk/floppy disk controller. For comparison purposes, a Computer Memories 20-megabyte disk drive was included, the type originally supplied with the IBM PC AT before its head-crash problems became legendary.

There is a wide array of products available to you from the mail-order companies and a growing number of private dealers, particularly some of the larger chains. They typically offer products from several major disk drive manufacturers in a variety of storage sizes and price ranges.

As with most bargains, however, there is a catch, and in this instance, the phrase "let the buyer beware" assumes new relevance. Mail-order disk drive buyers will now typically find little or no support from the retailer, a former long suit for the integrators. Buying an OEM drive from a local dealer usually offers a little more security, albeit at a generally higher price.

Adding a hard disk drive to your PC or compatible will result in perhaps the biggest performance gain short of buying a new computer. And once you've sampled the convenience of having all of your favorite software available at your fingertips without swapping floppy disks till the cows come home, you'll wonder how you ever got along without a hard disk.

AT-HARD DISK COMBO This is even more important when talking about the IBM PC AT or the many AT compatibles available. The only reason to order a truly formidable machine like the AT without a hard disk would be to hold down the initial cost. A good, fast hard disk puts AT-class computers into the realm that only a few

years ago was reserved for refrigerator-sized minicomputers.

Choosing an OEM mail-order hard disk for your PC is not a trivial task. Among the considerations are manufacturer, storage capacity, physical size, performance (particularly on the AT), accessories (mounting rails, cables, controller, and so on), and price.

Who the manufacturer of the hard disk drive is does not seem to be as important as it once was. There was a time when disk drive makers borrowed on their knowledge of minicomputer systems and built PC equivalents. Problems arose due to operational differences between PCs and minis—while the mini is typically left up and running all the time, the PC is generally turned off when not in use. As a result, the early units allowed the heads (which hover on a thin cushion of air during normal operation) to come in contact with the recording media, sometimes chewing up a section of the data area. Seeing the error of their ways (made all the clearer when they were forced to replace a significant number of disk drives under warranty), most disk drive builders have added automatic features to park the heads in a dedicated landing zone on power-down.

Storage capacity is largely a matter of personal preference, but the biggest bargains in OEM disk drives are in the 20- to 40-megabyte range. Few will need more capacity than this, but disk drives up to 600 megabytes are available if needed.

The physical size of a disk drive will largely be dictated by the current configuration of your PC. Disk drives from 20 to 40 megabytes are widely available in either full- or half-height formats. Larger-capacity disk drives, because of their greater number of magnetic surfaces, will likely be full-height only.

Performance, generally measured in access time, is not particularly important for owners of 8088 microprocessor-based machines like the PC and XT. These systems are largely bound by the rate at which the CPU can handle the data thrown its way by the disk drive. Consequently, buying a hard disk with an access time of less than about 85 milliseconds will not yield any increase in performance.

This is not the case for owners of AT-class machines. These systems, with their

STREET SMART

A quick survey of mail-order ads in computer publications confirms that you'll rarely pay the manufacturer's suggested retail price for a hard disk drive. Disk drives from Miniscribe, for example, are advertised for up to \$200 less than the list price. List price for Miniscribe's 70-megabyte 6085 model is \$995, but you can find it for as little as \$799. Likewise, the 26-megabyte 6032 from Miniscribe, listed at \$563, can be had for \$479. Seagate drives are also discounted, as are most of the other products reviewed here. A 30-megabyte Seagate drive that lists for \$575 is advertised at \$429 by 47th Street Computer in New York. Prices quoted in the reviews were supplied by the manufacturers. You should be pleasantly surprised by the price difference when you shop the mail-order houses.—*Nora Georgas*

Nora Georgas is an associate editor at PC Magazine.

16-bit bus structure and faster 80286 microprocessors, can benefit from faster disk drives. Although an 80-millisecond disk drive can be used, the full potential of these machines will not be realized unless the disk has an average access time of under 40 milliseconds. On these higher-speed disk drives, the head actuator will probably be the more advanced voice-coil-servo type, rather than the band-stepper configuration in the slower disk drives.

As with physical-size considerations, the extras needed with the disk drive will be determined by your current hardware configuration. If your PC is currently running with only floppy disk drives, you will need a hard disk controller and cables to connect the hard disk to it.

AT owners will also require mounting rails to place the hard disk into the AT's chassis. Since most AT-compatible systems come with a controller for two floppy disk drives and two hard disks, only the rails and cables will be needed.

If you are installing an aftermarket disk drive in a PC- or XT-compatible machine,

■ MAIL-ORDER HARD DISKS

make sure that the firmware BIOS on the controller board supports the disk drive you will be using. The dealer or mail-order firm should be able to help you out in this regard. To further simplify things, some manufacturers also bundle hard disk drives with controllers guaranteed to work.

LIMITING THE CHOICES XT and AT owners can simplify their disk drive choice somewhat by purchasing a preformatted disk drive that works with the SET-UP utility on the system disk supplied with their machines. Remember, not all disk drive types are usable on these computers. In addition, some of the clones, such as the PC's Limited AT, offer a number of extra choices in the system ROM.

Many hard disks come from the manufacturer with a low-level format (meaning that the individual magnetic tracks and sectors have been mapped out) already performed on the disk drive. This allows you to plug it in, run the conventional DOS FDISK and FORMAT programs, and be up and running. For a number of the larger-capacity disk drives, however, help may be required in terms of setup software (see sidebar "Disk Formats Made Easy"). Be sure to inquire about formatting before you buy.

Price is something only you can decide for yourself. There are no absolutes in the mail-order market, and prices for comparable products vary widely between companies. Don't be too concerned with suggested retail prices, because it's unlikely you'll pay that much for disk drives of this sort. One constant remains—the larger or faster the disk drive, the more it is likely to cost.

Be careful not to overestimate your mechanical prowess if you intend to install the disk drive yourself. You'll have to remove the case and possibly the floppy disk drives, and install the hard disk and controller. Along the way, you may encounter a number of screws, cables, DIP switches, and jumpers. If you have any doubt, ask a dealer (or at least a technically capable friend) to do it for you.

One final note: be very careful before installing a hard disk drive in an older-model IBM PC, because the early units came equipped with a puny 65-watt power supply that may well fry when a hard disk

and controller are installed. The 135-watt XT and 200-watt AT power supplies will have no problem with the additional load. The same mail-order companies that sell the disk drives will be happy to equip you with a more robust power supply for your PC hard disk installation, and at a similar bargain-basement price.

Fujitsu America Inc.

Fujitsu America's Storage Products Division has been manufacturing hard disk drives since 1978. Recently, the Peripheral Products line has expanded into the printer market. All of Fujitsu's disk drives are manufactured in Japan.

Anachronism may well be the word that best describes the Fujitsu M2235AS hard disk drive. A robust 6-pound, full-height unit, its size and bulk seem out of place for a contemporary 21-megabyte drive.

The disk drive assembly itself is packed in a die-cast aluminum housing topped by a relatively thick stamped aluminum top plate. Beneath it, however, is a pair of piggyback circuit boards with an unusually

high component count, particularly resistors and transistors (remember those?). The boards are otherwise neatly laid out and assembled with obvious attention to quality. Installation parameters are set by means of DIP switches, rather than the often-more-difficult jumpers.

The entire disk drive is mounted to a stamped steel frame by means of well-designed rubber isolation bushings. The frame has holes tapped in both the bottom and sides for installation in a variety of systems.

After installing the M2235AS in an AT-compatible computer, I booted it up and wondered if the system had somehow taken control of my vacuum cleaner. The spindle motor sounds surprisingly fanlike, and a closer inspection showed that this was not far off the mark. On the outside of the external rotor were $\frac{1}{16}$ -inch-long projections spaced about every $\frac{1}{4}$ inch. Their purpose is presumably to provide a cool breeze to the circuit boards, but the noise is none too cool. Thankfully, the band-step-per head motor is significantly quieter.

As might be expected from this less-



The three Fujitsu full-height hard disk drives we tested cover a wide range of storage capacities. The M2235AS has a capacity of 21 megabytes, the M2242AS, 45 megabytes, and the M2243AS, 72 megabytes. All were solid performers, though not nearly as fast as some of the drives that sported obviously newer technology.

MAIL-ORDER HARD DISKS



FACT FILE

Fujitsu America Inc.
3055 Orchard Dr.
San Jose, CA 95134
(408) 946-8777

Fujitsu M2235AS

List Price: \$585 in quantities of 100.

Capacity: 21 Mbytes.

Size: 5 1/4-inch full-height.

In Short: A product of somewhat dated technology, the M2235AS is an adequate, if not outstanding, hard disk drive. Noise from the spindle motor is perhaps its biggest fault.

CIRCLE 88 ON READER SERVICE CARD

Fujitsu M2242AS

List Price: \$1,210 in quantities of 100.

Capacity: 45 Mbytes.

Size: 5 1/4-inch full-height.

In Short: A quiet and robust hard disk drive, well suited to the needs of powerful AT-class computers.

CIRCLE 89 ON READER SERVICE CARD

Fujitsu M2243AS

List Price: \$1,350 in quantities of 100.

Capacity: 72 Mbytes.

Size: 5 1/4-inch full-height.

In Short: A large-capacity, high-performance disk drive offering quality construction and quiet operation for those with substantial storage requirements.

CIRCLE 90 ON READER SERVICE CARD

than-state-of-the-art technology, the 21-megabyte Fujitsu M2235AS is also among the slowest disk drives that we tested, with an average random-access time of 56 milliseconds on the Core International DISKP performance test. We noted similar performance during directory creation and file writing.

In all fairness, however, the M2235AS still exceeds the requirements set for the IBM PC-XT by a comfortable margin. The technical reference manual supplied with the M2235AS states that the specially lubricated oxide drive media is designed for approximately 10,000 start/stop operations. While that's a seemingly large number, it probably wouldn't hurt to park the unit's heads in the landing zone before turning the power off.

Although outwardly similar to the smaller Fujitsu disk drive, the larger model

incorporates more advanced technology and higher performance to make them much more attractive.

The 45-megabyte M2242AS and 72-megabyte M2243AS are clearly two peas from the same pod, the only significant difference being the number of magnetic platters calling the full-height die-cast enclosure home. The 45-megabyte disk drive has 7 read/write heads, while the 72-megabyte unit has 11, both units writing to 754 cylinders.

Both disk drives incorporate the latest servo-voice-coil head-positioner technology for quicker response time in reading data stored on the oxide-coated disks. This results in 33-millisecond average access times and performance that's certainly adequate for AT-class machines.

Gone are the fanlike projections found on the smaller drive's rotor. Consequently, these disk drives are somewhat quieter than average and quite unobtrusive in sustained use. The servo-voice-coil head actuator produces only an insignificant ticking sound when active. As you might expect, the greater number of heads in the 72-megabyte model results in slightly more vibration when compared with the smaller drives.

Like Fujitsu's 21-megabyte disk drive, the larger drives have a relatively high component count. In the case of the larger drives, the number of circuit boards rises from two to three, each packed with as many integrated circuits and discrete components as seems possible. Assembly quality remains a cut above that of many of the competitors, however.

Fujitsu's are the only disk drives tested for which the manufacturer does not suggest a retail price. Consequently, you'll be on your own when checking out prices through the mail-order ads or local dealerships.

Microscience International Corp.

Microscience International Corp. opened its doors for business in 1982. Its product line consists exclusively of half-height hard disk drives. It currently builds both 5 1/4-inch and 3 1/2-inch disk drives and recently introduced a plug-in drive-on-a-board known as the EasyCard. Its current

products are being manufactured in Singapore and the United States, and a new plant for production of high-performance units is nearing completion in Taiwan.

The Microscience HH725B is a fine choice for those wishing to add hard disk capabilities to their PC or XT. Although it was the slowest of all of the disk drives tested, its construction and operational characteristics make it worthy of consideration.

With 21 megabytes of formatted storage capacity tucked into a half-height frame, it will easily fit into just about any system.

The low performance levels are primarily due to the use of band-stepper head-positioning technology. Although certainly slower than the voice-coil-servo system used in faster units, it is nevertheless a good selection for those with 8088- or 8086-based systems like the PC or XT.

Unusual for a disk drive of this type is the use of thin-film-plated media, considered more rugged than the more common-place oxide coating found on many lower-priced disk drives. This, combined with a low-mass head assembly, supports Microscience's claim that the unit is suitable



FACT FILE

Microscience International Corp.
575 E. Middlefield Rd.
Mountain View, CA 94043
(415) 961-2212

Microscience HH725B

List Price: \$354

Capacity: 21 Mbytes.

Size: 5 1/4-inch half-height.

In Short: A fairly slow but nonetheless quiet and pleasant disk drive to use in a PC or XT. Thin-film disk technology offers the promise of long life and suitability in portable systems.

CIRCLE 91 ON READER SERVICE CARD

Microscience HH1050

List Price: \$923

Capacity: 44 Mbytes.

Size: 5 1/4-inch half-height.

In Short: A particularly fast and compact drive, suitable for installation in just about any IBM compatible made today—and may be tomorrow.

CIRCLE 92 ON READER SERVICE CARD

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CIRCLE 521 ON READER SERVICE CARD



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It takes four of theirs to display the same spreadsheet as one Amdek 1280.

Now, Lotus 1-2-3 and Symphony can be even easier and quicker to run. Because Amdek's 1280 graphics subsystem displays up to four times more spreadsheet than a standard IBM monochrome or compatible monitor.

For incredibly vivid resolution, the Amdek system puts 1280 X 800 pixels on a big 15" white phosphor CRT.

There are a total of 11 modes. What's more, the 1280 provides complete monochrome and color graphics compatibility.

Price? The Amdek 1280 monitor and video board cost only \$999. So, if you work with Lotus, CAD or desktop publishing, Amdek's 1280 graphics subsystem is clearly your best buy.

The Amdek 1280 provides 1280(H) X 800(V) resolution with these software packages:

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Compound Document Processor
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CIRCLE 102 ON READER SERVICE CARD



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PC Magazine, March 10, 1987

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MAIL-ORDER HARD DISKS

may also mean longer disk drive life.

With this much speed, the HH1050 will be equally at home in an AT as in a PC or XT. For that matter, it should work well in an 80386-based machine, should you decide to upgrade at some time in the future.

Miniscribe Corp.

Someday I fear that the Selective Service is going to reactivate my draft number and tell me that I'm allowed to take my computer and one hard disk of my choice along into battle. Deciding whether to stay and fight or move to some obscure tropical island might be difficult, but choosing a disk drive to take would be simple—Miniscribe. Quiet, lightning-quick, and built like C5-A transporters, these disk drives have it all.



FACT FILE

Miniscribe Corp.
1861 Left Hand Circle
Longmont, CO 80501
(303) 651-6000

Miniscribe 6032
List Price: \$563
Capacity: 26 Mbytes.
Size: 5 1/4-inch full-height.

In Short: Although perhaps bulky for its capacity, the Miniscribe 6032's high-speed performance and low noise level make it a great choice for AT-type machines.

CIRCLE 600 ON READER SERVICE CARD

Miniscribe 6053
List Price: \$639
Capacity: 44 Mbytes.
Size: 5 1/4-inch full-height.

In Short: The Miniscribe 6053 may represent the best price/performance value available today. Throw in quiet operation and rugged construction, and it sets a market standard.

CIRCLE 601 ON READER SERVICE CARD

Miniscribe 6085
List Price: \$955
Capacity: 71 Mbytes.
Size: 5 1/4-inch full-height.

In Short: A large-capacity, very high speed hard disk drive, the Miniscribe 6085 can unleash the true potential of AT-compatible systems. Quiet operation and low price sweeten the pot.

CIRCLE 607 ON READER SERVICE CARD



Miniscribe's three full-height hard disk drives are built like tanks, with heavy die-cast enclosures and strong, cast-aluminum frames. The 6032 (left) offers 26 megabytes of storage and the 6085 (right), 71 megabytes. The 6053 (center) is an Editor's Choice. It offers the best performance for the money and operates more quietly than the competition.

Although the disk drives sent for review were assembled in the United States, Miniscribe Corp. also has a plant in Singapore producing other products. Miniscribe's product line consists exclusively of hard disk drives, both 3 1/2-inch and 5 1/4-inch. It is now also manufacturing hard disks mounted on plug-in boards.

When I first opened the box of test units, I thought I had three of the same model. The only indications that they weren't identical were the model numbers. The resemblance is more than just superficial, the only differences being the number of recording platters and read/write heads. In every other aspect, they are the same.

In contrast to many other hard disk manufacturers' product lines, in which smaller disk drives are often saddled with lower-performance designs, the technically advanced features of Miniscribe's high-speed 71-megabyte drive are carried over to the 44M and 26M units as well, giving them outstanding performance for their capacity.

The Miniscribe 6032 26-megabyte

drive has three read/write heads, the 44-megabyte Miniscribe 6053 five, and the 71-megabyte Miniscribe 6085 eight. All three write to 1,024 cylinders per magnetic surface, and all use servo-voice-coil head actuators.

The Miniscribes share a very heavy die-cast disk drive enclosure that's firmly mounted (through rubber isolation bushings) to an uncommonly robust, cast aluminum full-height frame. A number of ribs are cast into the disk drive housing, presumably to reduce transmission of head actuator noise to the outside world. On the bottom of the assembly is a single board with all of the circuitry packed rather tightly. Although it's fairly well assembled, there are a couple of wire jumpers soldered between IC legs that cheapen its appearance a bit.

Put any of the Miniscribes into a high-speed AT clone, connect the cables, and turn on the juice, and you'll quickly see just how terrific they are. All three were right at the top of the class in terms of speed. As expected, the larger the disk

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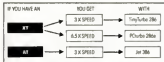
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CPU	8 MHz 80286	10 MHz 80286	10 MHz 80386
RAM	8K Cache	1 or 2 MB 286	64 K Cache



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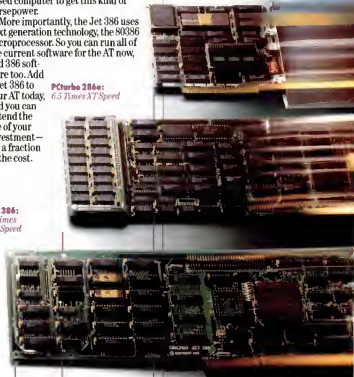


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Circle R. S. 306 for Jet 386

■ MAIL-ORDER HARD DISKS

drive, the quicker it was at writing a file. This is due to the greater number of magnetic surfaces, allowing more data to be written before the head assembly had to move.

On the subjective side, all three Miniscribes were quieter than most other disk drives during normal operation. Programs such as the benchmark tests, which require a lot of head movement, produced a subdued clicking sound—noticeable but not distracting in the least. Also as expected, the greater head mass of the larger drives produced a trifle more noise than the smallest. Only time can tell if these disk

■ A quick check of the mail-order ads shows the three Miniscribe products reviewed here to be among the cheapest disk drives available.

drives will have any long-term reliability problems, but I have no reason to think they will. And should you decide to upgrade to a higher-performance computer in the future, it's comforting to know that you won't have to spring for a new hard disk drive at the same time—they're unlikely to put a damper on the performance of any system. To put the frosting on the cake, a quick check of the mail-order ads shows the three Miniscribe products reviewed here to be among the cheapest disk drives available. Just pick the capacity that meets your requirements or the price that fits your budget.

DISK FORMATS MADE EASY

Storage Dimensions' SpeedStor makes hard disk installation a breeze.

One of the most difficult problems encountered when installing a hard disk in an XT or AT arises when the drive parameters (number of cylinders, heads, or precompression) do not match one of the types contained in the system ROM or SETUP program.

IBM wisely allowed for this by leaving drive type 15 undefined, but putting the proper configuration into the battery-backed CMOS RAM on those systems can be a major headache. Rarely is software for this purpose provided with mail-order drives. You can do it yourself with an intimate knowledge of assembly language programming and a few hours with the IBM technical reference manuals. A BASIC program that pokes the correct values into the CMOS memory segment might also work.

A much better solution exists in the form of *SpeedStor*, Version 4.02, a hard disk integration utility program from Storage Dimensions. This well-documented, comprehensive package makes installing just about any hard disk currently available a breeze.

Running the program couldn't be simpler—boot the computer with a DOS disk, insert the *SpeedStor* disk, and type *Install*. Go have a Dr. Pepper and when you come back in half an hour or so, the drive will be formatted and ready to roll.

The *Install* batch file runs both the low- and DOS-level format programs, installs a device driver at the root directory level, and modifies the CONFIG.SYS file to include the device=harddisk.sys pointer to that driver.

Extensions to the installation batch file can be executed at the command line level to install a second drive or to set up a partition larger than the normal 32-megabyte DOS limit.

By default, *SpeedStor* will format a disk drive under the 32-megabyte capacity as a single DOS drive (drive C: for the first drive and D: for the second). For drives of higher capacity, the program formats the drive as a number of logical device names, each of equal drive capacity. In other words, a 42-megabyte drive will be formatted as two 21-megabyte drives assigned names C: and D:.

In the event that the installation batch program does not meet your needs, the main program (*Hardprep*) can also be run from a menu-driven mode, allowing you to select drive characteristics manually.

With all of the input/output going through the device driver, it would not be unreasonable to expect performance to suffer, but that just didn't prove to be the case. The fastest AT-compatible drive at hand ran benchmark tests with no appreciable difference from the numbers ob-



FACT FILE

SpeedStor

Storage Dimensions

981 University Ave.

Los Gatos, CA 95030

(408) 395-2688

List Price: \$99; semiannual updates, \$10.

Requires: DOS 2.1 or later.

In Short: A comprehensive, well-documented program for configuring hard disks to run with PCs.

CIRCLE 186 ON READER SERVICE CARD

tained with the drive installed in the conventional manner.

If all this weren't enough, *SpeedStor* includes a number of advanced hard disk diagnostics features, such as tests of the controller, a seek test, read and write tests, and bad track lockout. A partition editor also allows you to change the size of existing DOS partitions. The only negative aspect of the package is that the disk is copy protected (just when we thought that was coming to an end). At \$99, this program can save hours of grief for those with nonstandard hard disk requirements. Updates are published approximately every 6 months and are available to registered users for only \$10.

—Frank Bican

■ MAIL-ORDER HARD DISKS

Rodime Inc.

The land of the Loch Ness monster and those wonderful whiskies might be the last place you would expect hard disk drives to be manufactured, but Rodime does indeed call Scotland home.

Rodime claims to be one of the largest hard disk makers in the world, but until very recently that was a well-kept secret—its products were sold without labels to OEMs who added their own name to the product. They are now distributing their product to dealers and mail-order firms under the Rodime name.

It was Rodime, in fact, who invented the little 3½-inch hard disk drive now found on a plethora of card-mounted hard disk systems. When problems started cropping up with the CMI drives originally packaged with IBM's AT, the 33-megabyte Rodime RO203E was one of the only replacement units available that met IBM's disk drive specifications. It remains a suitable (and popular) choice for those systems today.

The husky disk drive housing uses cv-



Rodime's RO3055 (left) is a half-height gem, whose performance and incredibly high quality make it an easy pick for Editor's Choice. The full-height RO203E is very big and may be difficult to install, but once ensconced in the drive bay it is a smooth and capable performer. It won't set any speed records, but for average use it works with no problems.



FACT FILE

Rodime Inc.
901 Broken Sound Pkwy.
Boca Raton, FL 33431
(305) 994-6200

Rodime RO203E

List Price: \$695

Capacity: 33 Mbytes.

Size: 5¼-inch half-height.

In Short: An IBM PC AT-specification disk drive with a particularly quiet and ingratiating nature. While breaking no new performance ground, it makes an excellent choice for day-to-day use.

OFFICE 686 ON-READER SERVICE CARD

EDITOR'S
CHOICE

Rodime RO3055

List Price: \$995

Capacity: 44 Mbytes.

Size: 3½-inch half-height.

In Short: Quite simply, the fastest, quietest, most compact hard disk drive tested. Its diminutive size allows installation in any system, and the performance levels are far ahead of the needs of an AT. This disk drive should work beautifully with the high-speed 80386-based machines now appearing.

OFFICE 686 ON-READER SERVICE CARD

ery bit of space provided in the full-height standard—a bit of gentle persuasion was required to fit it into the opening of a PC's Limited AT system. Beneath the disk drive housing are a pair of circuit boards, each with a somewhat-lower-than-usual component count. A tiny additional board is mounted on the front of the disk drive and covered with a copper shield to preclude leakage of radio-frequency interference signals.

Both the spindle-drive motor and the head-stepper motors were physically larger than any of the other disk drives that we tested. The mass of the motors may account for the very low heat levels—even after a full evening of being powered up. An added bonus for a band-stepper-driven head assembly is a solenoid-controlled lock for the stepper motor. This mechanism prevents the heads from being accidentally dragged across the platters if the disk drive is moved about.

Performance figures were typical of many disk drives aiming at the AT replacement market. They were adequate, and

certainly up to IBM's specifications, but not exceptional.

In everyday operation, however, the Rodime RO203E proved to be one of the most pleasant of the bunch. I had the opportunity to use it for several weeks before I had to return it to its rightful owner, and it was with some reluctance that I pulled it out of the AT clone. It's very quiet and virtually vibration-free, far different from some of its voice-coil-driven brethren.

At the very last minute, Rodime shipped an RO3055 44-megabyte 3½-inch drive for review, and it was well worth the wait. We've all heard the cliché that good things come in small packages, and the lilliputian Rodime is proof positive.

The visual impression of the RO3055 is rather like that received when first hoisting a fine German 35mm camera—quality is the bottom line. The precision die-cast aluminum disk drive housing is attached to an equally fine mounting frame. On the bottom of the unit is a single, petite circuit board built almost entirely with the latest surface-mounted devices on both sides.



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CIRCLE 318 ON READER SERVICE CARD

MINIMUM HARDWARE REQUIREMENTS:
IBM PC XT/AT or compatibles and Tandy 1000/1300, 128K memory, one disk drive, PC DOS, MS-DOS 2.0 or higher. Color or monochrome monitor.

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■ MAIL-ORDER HARD DISKS

The only holdover from older technology is the socketed ROM chip.

Describing the Rodime RO3055 is a wonderful pastime, but using it is the real joy. No disk drive tested faster or quieter than this one, period. It zipped through the benchmark tests faster than neutrinos through a vacuum.

In normal operation, the disk drive will never remind you of its presence with untoward noise. In fact, I had to put my ear to the case to make sure the critter hadn't gone belly-up during the seek test on the IBM advanced diagnostics disk, one of the noisiest operations yet devised.

The only reservation I have is the significant amount of heat generated by the disk drive during extended use. It was very warm to the touch after a couple of hours. This is likely the result of jamming so many components into such a small space.

With its small size and Herculean performance, the reasonable price of the Rodime RO3055 is a real treat. If Leica were to build a disk drive, this would be it.

Seagate Technology

Seagate Technology claims to be the leading manufacturer of 5¼-inch hard disk drives, and with over 5 million installed to date, there seems no reason to doubt it.

Founded in 1979, Seagate employs 15,000 people worldwide, with most of its manufacturing done in Singapore and Bangkok.

The first Seagate disk drive we looked at was the ST4038, a full-height drive with a 31-megabyte capacity that is assembled in Singapore.

Seagate construction quality appears to be a bit above average. The cast aluminum disk drive housing is mounted at all four corners to an exceptionally sturdy (and consequently heavy) stamped steel mounting bracket. AT-style mounting rails are attached with Torx screws, rather than the more-common Allen or Phillips types. Plan on going deep into the toolbox if you need to remove them.

The disk drive unit is sandwiched between two neatly made circuit boards stuffed with a higher-than-usual number of components. At any rate, everything remained cool to the touch even after being powered up for several hours.



Seagate Technology is synonymous with hard disk drives, and with good reason. Its ST238, priced at \$310, is a low-cost classic and winner of the Editor's Choice nod for its price and above-average performance in XT situations. For your AT, the 30-megabyte ST4038 is another good choice. At \$575 (and perhaps lower with a little shopping around), it's a true bargain.



FACT FILE

Seagate Technology
920 Disc Dr.
Scotts Valley, CA 95066
(408) 438-6550

Seagate ST4038

List Price: \$575

Capacity: 31 Mbytes.

Size: 5¼-inch full-height.

In Short: A perfect choice for installation in AT-class computers. Somewhat high on low-frequency vibration but low on noise, it is quite unobtrusive in everyday operation.

CIRCLE 584 ON READER SERVICE CARD

Seagate ST238

List Price: \$310

Capacity: 21 Mbytes.

Size: 5¼-inch half-height.

In Short: Higher-than-average performance, pleasant operation, and generally low mail-order prices make this disk drive a fine choice for your XT or PC. Combine it with an RLL controller board, and you'll have 30 Mbytes of storage at a 20-Mbyte price.

CIRCLE 585 ON READER SERVICE CARD

EDITOR'S
CHOICE

Primarily intended as a replacement for the IBM PC AT or any of its many clones, the Seagate ST4038 performs almost identically to the CMI drive originally sold with the AT. Both sequential and random-access tests were comfortably within IBM's specifications for the AT. For the latest crop of 12-MHz AT compatibles, though, it might be a bit slow.

During testing, the big Seagate drive was actually more amusing than obtrusive. Normal disk drive operation was accompanied by generally quiet operation and low vibration levels.

The fun started when the PC Labs headseek-intensive benchmark tests or advanced diagnostic programs were run. Apparently, the head actuator is of relatively high mass, and programs requiring it to move far often caused the drive and anything around it to move. While we were running the seek test on the IBM advanced diagnostics disk, the Seagate ST4038 made not just the computer sway to and fro, but even the desk it rested upon. It was enough to rattle the ice cubes in a glass sitting upon the desk. Thankfully, this (or

■ MAIL-ORDER HARD DISKS

any other) disk drive probably won't be called upon to run such demanding software very often.

The Seagate ST238 is one of the company's most popular and versatile products. A lightweight, half-height package, the smaller Seagate will be perfectly happy

■ **Performance is also a strong point of the Seagate ST238. It was consistently faster than any of the other low-priced 21-megabyte disk drives tested.**

in transportable computers, as well as PCs and XT's.

Rather than having the usual configuration of a head-stepper motor mounted on the side of the disk drive, the Seagate ST238 uses a pancake-style stepper motor mounted on the bottom (and indeed, partly enclosed by the disk drive housing). Because of this, the disk drive runs quieter than most during programs that require a lot of head seeks.

Performance is also a strong point of the ST238. It was consistently faster than any of the other low-priced 21-megabyte disk drives tested, enough so that it wouldn't bring an AT to its knees if installed in one.

Storage capacity of the Seagate ST238 might confuse you a bit if you just look at the mail-order ads. Many list it as a 30-megabyte disk drive, but that's because they often package it with a run length limited (RLL) disk drive controller board. The different data encoding scheme utilized by RLL controllers allows drive capacity to typically increase by 50 percent. Seagate assured me that this disk drive is particularly well suited to RLL boards, a claim some others can't make. With their low prices and capable performance, it's easy to see how Seagate disk drives became so popular with PC users.

Tandon Corp.

For the past 11 years, Tandon Corp. has been supplying both floppy and hard disk drives to the microcomputer community. More recently, it has begun manufacturing XT- and AT-compatible systems and card-mounted hard disks under its own name.

The Tandon TM9755AI will appeal to speed demons looking for 42 megabytes of storage space crammed into a half-height mount. Inside the little disk drive are three platters of rugged plated media and a technically advanced servo-voice-coil head assembly. The single circuit board on the bottom was uncommonly well made and component-sparse, bettered only by the smaller 21-megabyte Tandon. Rubber isolation bushings keep vibration from the head assembly to a minimum.

In terms of sheer speed, this lightweight disk drive packs heavyweight performance. It ranked with the best in terms of access-time and file-writing benchmark tests. Regardless of its small size, it would be perfectly at home in an AT-class computer, particularly when you consider that the half-height frame would rest comfort-



FACT FILE

Tandon Corp.
405 Science Dr.
Moorpark, CA 93021
(805) 378-6081

Tandon TM9755AI

List Price: \$1,550

Capacity: 42 Mbytes.

Size: 5 1/4-inch half-height.

In Short: A high-speed disk drive with ample storage space within the half-height enclosure, its overall performance is slightly marred by a fairly high level of noise from the head actuator assembly.

CIRCLE 688 ON READER SERVICE CARD

Tandon TM9262AI

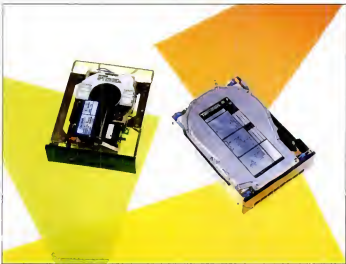
List Price: \$520

Capacity: 21 Mbytes.

Size: 3 1/2-inch half-height, mounted in a frame for 5 1/4-inch openings.

In Short: The perfect hard disk to add to a portable computer, it will work equally well in XT- or PC-compatible systems. The drive's low noise levels make it a pleasure for extended use.

CIRCLE 689 ON READER SERVICE CARD



The Tandon TM9755AI (right) is a half-height speed demon with a formatted capacity of 40 megabytes. Despite its small size, it would be at home in an AT-class machine. The TM9262AI (left) has a surprise inside: a 3 1/2-inch hard disk drive mounted on a frame that fits into a 5 1/4-inch drive bay. It is designed for use in PC- and XT-compatible machines.

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MAIL-ORDER HARD DISKS

ably in the seldom-used hard disk drive space beneath the floppy disk drives.

In everyday use, the Tandon TM9755AI is a little noisier than the competition. The disk drive assembly is topped by a thin aluminum plate that allowed much of the head-motion noise to escape into the room. The sound was rather scratchy and unpleasant. Stamping some stiffening ribs into the top would likely eliminate much of the noise.

I wasn't able to find a mail-order listing for this product to check the real-world price, but the manufacturer's suggested retail price seems a mite out of line with the competition.

Now forget about the 42-megabyte Tandon, and let's start fresh with the company's smaller 21-megabyte Tandon TM9262AI disk drive, because this one was unique among all those tested.

This 5¼-inch half-height disk drive isn't really a 5¼-inch unit at all. Rather,

■ With smaller, low-mass components to move around, the TM9262AI was just about the quietest mail-order disk drive tested.

it's a 3½-inch disk drive fitted into a frame designed to fit into a 5¼-inch mounting space. It's odd-looking at first, but it seems to work quite well.

Compared with many of the full-height drives in the test, the 3½-inch assembly appears almost toylelike. But like the larger members of the group, the little Tandon houses the disk drive mechanism in the familiar die-cast aluminum case. The equally small single circuit board holds the fewest components of any disk drive tested. This may also account for the drive remaining cool to the touch after running for several hours. Don't be misled by the baby Tandon's small size, however, because it is perfectly capable of holding its own with the big boys. In terms of benchmark tests, it was one of the slower drives in the group, but still well above the standards set by IBM for use in the XT.

With smaller, low-mass components to move around, the Tandon TM9262AI was just about the quietest mail-order disk drive tested, second only to the accident-prone CMI in the original IBM PC AT. Vibration from the head actuator assembly was virtually nonexistent. It's unlikely that you'll ever be aware of this drive in normal operation; that's certainly a desirable attribute.

The very low weight, durable plated recording media, and low power consumption make this disk drive an excellent choice for installation in a transportable computer.

Frank Bican is a departmental computer resources supervisor at a Cleveland medical center.

PC EDITOR'S CHOICE

- Miniscribe 6053
- Rodime RO3055
- Seagate ST238

Most every drive reviewed here has some appealing feature to recommend it. Add to this vast differences in performance, price, and physical characteristics, and the choice of a clear winner should become somewhat fuzzy, but that didn't happen. The Rodime RO3055 was so fast and quiet that the others never stood a chance. Its jewel-like precision and tiny package only add to the charm.

If physical size isn't a consideration, the Miniscribe 6053 offers the best performance for the buck, with quiet operation and tanklike construction thrown in to make it just that much nicer.

The Seagate ST238 is just the ticket for those on a limited budget, and no apologies need be made for the better-than-average performance.

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SYSTEM INTEGRATORS:

Hard Disks with All the Extras

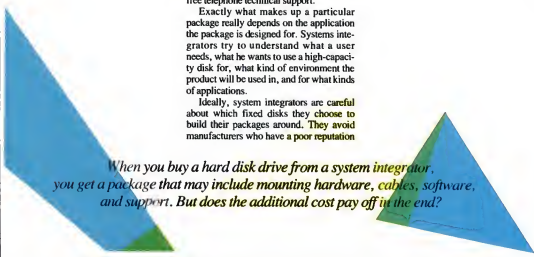
Deciding where to get your high-capacity hard disk is just as important as choosing which one to buy. A bad choice could leave you high and dry with a disk that doesn't do what you had in mind, and with no one to call if you run into trouble installing or using it.

One answer is to purchase a high-capacity disk package put together by a system integrator. System integrators, or sub-system houses, as some companies prefer to be called, buy bare-bones hardware from disk manufacturers, add improvements, and then make the complete package available to dealers and end users.

Those improvements can include added hardware, software, better installation manuals, extended warranties, and toll-free telephone technical support.

Exactly what makes up a particular package really depends on the application the package is designed for. Systems integrators try to understand what a user needs, what he wants to use a high-capacity disk for, what kind of environment the product will be used in, and for what kinds of applications.

Ideally, system integrators are careful about which fixed disks they choose to build their packages around. They avoid manufacturers who have a poor reputation



When you buy a hard disk drive from a system integrator, you get a package that may include mounting hardware, cables, software, and support. But does the additional cost pay off in the end?

■ SYSTEM INTEGRATORS

or who haven't been around long enough to establish a track record. Drives are tested when they're received from the manufacturer, and any that are mechanically flawed or that don't meet the integrator's own performance standards are quickly weeded out.

The components the integrator adds to the drive are also carefully tested. But, more importantly, they're designed from the outset to match the drives they're sold with. Most integrators control the entire process by manufacturing their own controller cards and developing their own software.

The matched fixed disk drives, controllers, and software are tested together before they're packed, and integrators make sure those tests reflect realistic conditions. For instance, packages are tested in different PC models and in major compatibles using different operating systems. They're also tested with various applications and environments, such as networks, to guarantee that they'll not only work but will also provide the level of performance you expect.

Developing their own hardware and software also means that system integrators are able to give more capability than you could get by matching components off the shelf. The software, in particular, tends to include utilities and supplementary disk operating systems that provide a high degree of control over a high-capacity disk.

All of the integrators currently committed to the IBM PC market have a wide product line. Based on their understanding of user needs and common applications, they've done the basic shopping for you and have assembled packages that can handle the majority of situations.

If you don't want to take a chance on overbuying, but suspect your storage needs might increase, don't worry. Some of the integrators offer upgrade policies that allow you to buy a small drive now and get credit for the amount you paid if you trade up to a larger unit. They also handle complementary storage media, such as tape backup systems that are matched to the disk drives they carry.

Installation can often present some difficulties. Most systems houses try to carry products that are installable in a few minutes by a dealer, or in a very short time by

even an inexperienced user. Many of the companies handle the installation problem by taking care of the more odious tasks, like low-level formatting, before the drives leave the warehouse. All of them take pains to supply installation and user's manuals that really increase the likelihood that you'll install everything correctly the first time.

■ **Integrators realize that unless they come through with reliability and support, they won't attract customers.**

The manuals tend to go beyond what's available from drive manufacturers. Since integrators try to anticipate the issues and problems that might come during the installation of a drive, they are careful to walk you through the process of installing the equipment and preparing it for use.

SUPPORT Support is one of those magic, much abused words in the PC products industry. Unless you're a wide-eyed innocent, you probably think of promises of support as so much propaganda. But system integrators absolutely have to provide adequate support, because they depend on their reputations to bring in customers.

The market for IBM PC fixed disks has become very competitive. It's not hard to find a dealer or mail-order house that can give you a similar product for less. Integrators realize that unless they come through with reliability and support, they won't attract customers.

Hence the general attitude among system integrators is that any problem you may have installing or using their package is their responsibility, not just their dealer's. Most of them have toll-free 800 numbers that you can call for technical support and staff those lines with trained personnel who can answer a wide range of equipment and applications-related questions.

The support they're able to give reflects

their attitude about putting together products that fit the way you want to use them. System integrators realize that most problems people have installing and using their equipment stem from the operating system and applications they're using, and not from mechanical problems with the hardware.

You also get support in the form of an extended warranty on the package you buy. Disk drive manufacturers typically give their customers—dealers and mail-order houses—12- to 18-month warranties. But the warranty you get from the dealer is usually shorter, often 90 days. System integrators typically provide a full 1-year warranty on their products.

Guaranteeing service and reliability costs money. You can expect to pay more for a package put together by a system integrator than you would for a similar product that goes directly from the manufacturer to a dealer or mail-order house. The higher price is the cost of ensuring that the product you get won't give you any problems. But the higher price is also making system integrators harder to find. Lower-capacity fixed disks for IBM PCs have become a consumer commodity where the competition is based exclusively on price.

System integrators don't compete on that level and have virtually abandoned that end of the market. Many integrators see the trend continuing into the high-capacity, high-performance disk drive market and are leaving that end also.

At present, only four companies are committed to supplying system integration for the IBM PC fixed disk market:

IDEAssociates, based in Billerica, Massachusetts, is a major distributor of a wide range of PC hardware and software products.

Sysgen is a major packager and distributor of storage media, including disk and tape drives. The company is located in Milpitas, California.

Mountain Computer, headquartered in Scotts Valley, California, also concentrates on packaging disk drives and other storage media.

Tandon Corp. differs from the other system integrators. The Chatsworth, California, company is a major manufacturer of disk drives, and has chosen to act as an integrator for its own products.

■ SYSTEM INTEGRATORS

The following reviews cover disk packages that the manufacturers feel are representative of their product line.

IDEASSOCIATES INC. **IDEAssociates** **Diskit A30**

The first impression you get when you open the box of the IDEAssociates' Diskit A30 30-megabyte fixed disk for the AT is that somebody forgot to pack something. All it contains is a full-height, 5¼-inch disk drive, data cable, and an installation manual. But looks are deceiving, because you're really getting a lot more than just what's in the box: what you're getting is a lot of preparation and backup from the folks at IDEAssociates.

That becomes obvious when you slip the A30 into the AT. Installation is a breeze. All it takes is about 15 minutes to slide the disk drive into place, connect the data and power cables, and then configure and format the disk with your standard IBM software.

The whole installation process is described in the manual. The manual is generic, applying to all of IDEAssociates' disk drives, and appears to cover the ma-



The 30-megabyte IDEAssociates Diskit A30 comes with a unique upgrade policy that gives you credit worth the price of the drive when you upgrade to a larger model.

jority of the situations you're likely to run into when installing a drive. Even the phone number for technical help at IDEAssociates is easy to find. The instructions for the A30 are complete and well illustrated.

IDEAssociates did not, however, identify their drive types according to their model numbers. So it's necessary to call the technical support number before you can get the right information into the AT's setup program.

Anyone planning to install the A30 in an AT clone could run into some problems with the fixed disk's address. The address is governed by a jumper and pins at the rear edge of the drive's circuit board and comes set up as drive 1 for an AT. Some clones require an address of 0 for the first drive, so the jumper needs to be changed.

Unfortunately the instructions for setting the jumpers are hard to understand and really don't furnish enough of the information needed to work out any unusual installation problems that can come up. The illustrations were identified by IDEAssociates disk type, which didn't do much good, and the drawing for the A30

didn't match the pin setup on the disk drive.

My day was saved by a very competent technical support person. He was able to handle questions about the major compatibles like the Compaq and AT&T off the top of his head, and he gave enough background information about the way the drive is set up to make puzzling out any other clones easy.

Once installed and turned on, the A30 really shows its stuff. It's a quick, powerful disk drive that performs at least as well as the stock IBM PC AT drive. The drive runs cool and is reasonably quiet.

The servo motors that move the heads around may have been overdone a bit, though. They're powerful and, in situations where tracks are being changed rapidly, literally push the drive around: drive, AT, and desk all shook to the shifting of the heads.

The last two invisible features that IDEAssociates stuffs into the A30's box are a full 1-year limited warranty and what looks like a foolproof way of making sure that you get enough fixed disk to cover your needs. If you think you might out-



FACT FILE

IDEAssociates Diskit A30

IDEAssociates Inc.
29 Dunham Rd.
Billerica, MA 01821
(617) 663-6878

List Price: \$1,035

Type: 30-Mbyte full-height, 5¼-inch hard disk for the AT.

Includes: Hard disk, data cable, installation manual

Manufacturer: Seagate. This is a Seagate ST-4038.

Requires: No special requirements for AT-compatibles.

Warranty: 1 year limited from IDEAssociates.

In Short: A true AT-level fixed disk that's easy to install and built to take abuse.

Prorated 4-year upgrade policy from IDEAssociates allows upgrade with credit for the original cost of the disk drive.

CIRCLE 661 ON READER SERVICE CARD

■ SYSTEM INTEGRATORS

grow the 30-megabyte capacity but don't want to pay extra right now for too much fixed disk storage space, you can buy the A30 and IDEAssociates will give you full credit for a hardware upgrade: 100 percent in the first year, 75 percent in the second, and so on.

MOUNTAIN COMPUTER INC.

Mountain FileSafe (62 MB) for the AT

The search for hassle-free installation is not going to end with Mountain Computer's FileSafe 62-megabyte fixed disk for the AT. That's a shame, because this drive has just about everything else you could want. It's well built, it operates about twice as fast as the IBM standard for AT drives, and it has excellent partitioning software.

But there's just no way you can install it right the first time.

The problem is the manuals. They're incomplete and poorly organized. For example, regarding physical installation, the basic message is to read your IBM Installation and Setup manual and to remember that what you see there isn't going to match



The Mountain FileSafe (62MB) hard disk drive is based on the Maxtor XT 1085 drive. The package includes a full complement of hardware accessories and software support.

the equipment you're installing. Even so, that part only takes about 5 or 10 minutes.

The rest of the installation can take forever, depending on how good a detective you are. Basically, what you have to do is patch DOS 3.10, low-level-format the disk drive, and then partition the disk and format the partitions.

All that information is in the Utilities Manual. It's just not in the right order. Follow the directions, and you'll have to repeat a lot of the steps because phrases like "before you attempt to . . ." tend to pop up two sections too late.

Even if you read the manual first and take notes before you start installation, the process is a long one—at least an hour, most likely two. Low-level formatting takes time. It took 2 hours of detective work before I could do it correctly and in the right order.

On the plus side, once you master the Utilities Manual, you have all the information you need to set up the FileSafe (62 MB) for just about any conceivable situation, including network file storage.

If you get hopelessly confused, there is no reason to panic. The Utilities manual

has a thorough troubleshooting guide. Moreover, the section starts with the phone number for Mountain's helpful technical support people, who are very sharp and knowledgeable about the company's line of products.

Once the FileSafe (62 MB) is up and running, it's easy to see that the basic product is a good one. The drive operates quietly and smoothly, without vibration, though when the heads change tracks it does make a low chirping sound that some people might find objectionable. The drive also gets a little hot, but that isn't so unusual for a fixed disk drive as big as this one is.

The software is complete and versatile. It can give you complete control over the disk drive and the ability to configure it just about any way you need to. One nice and useful feature is that you can partition the disk into up to 10 volumes of different sizes if you need to.

Overall, if you've got the determination and the patience, the FileSafe (62 MB) is worth the effort. As for the installation instructions, maybe sanity testing should be mandatory for the people who write those manuals.



FACT FILE

Mountain FileSafe (62 MB) for the AT

Mountain Computer Inc.
300 El Pueblo Rd.
Scotts Valley, CA 95066.
(408) 438-6650

List Price: \$2,395

Type: 62-Mbyte full-height, 5¼-inch hard disk for the AT.

Includes: Hard disk, data cable, mounting rails and hardware, full-height faceplate, partitioning and utilities software, installation and software manuals.

Manufacturer: Maxtor Corp. This is a Maxtor XT 1085.

Requires: 256K RAM, DOS 3.0 or later, IBM Advanced Diagnostics diskette, IBM AT manuals.

Warranty: 1 year limited from Mountain Computer, Inc.

In Short: A fast, well-built, very-high-capacity drive that's also very difficult to install.

CIRCLE 66 ON READER SERVICE CARD



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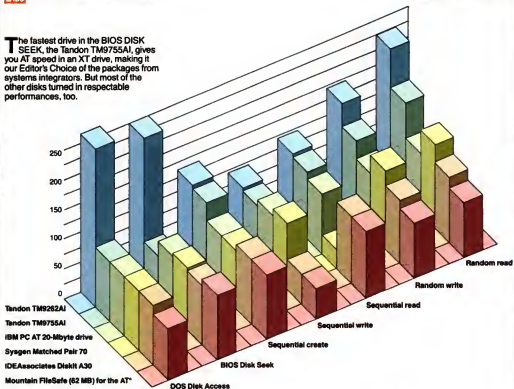
■ SYSTEM INTEGRATORS



Benchmark Tests: System Integrator Disks

Relative Times
(Ratio: IBM PC AT 20-Mbyte drive = 100)

The fastest drive in the BIOS DISK SEEK, the Tandon TM9755AI, gives you AT speed in an XT drive, making it our Editor's Choice of the packages from systems integrators. But most of the other disks turned in respectable performances, too.



Performance Times

(Times given in seconds except where noted)

	DOS Disk Access (milliseconds)	BIOS Disk Seek (milliseconds)	Sequential create	Sequential write	File Access Sequential read	Random write	Random read
Tandon TM9262AI	115.32	94.20	12.47	18.87	10.42	26.96	23.21
Tandon TM9755AI	43.70	27.24	12.12	16.62	10.06	22.10	16.15
IBM PC AT 20-Mbyte drive	43.50	37.35	9.39	20.36	8.73	17.30	10.25
Sygen Matched Pair 70	43.26	39.55	9.16	22.13	3.06	22.31	14.27
IDE Associates Disk II A30	42.90	37.43	10.15	10.20	10.05	17.88	11.49
Mountain FileSafe (62 MB) for the AT*	36.76	40.79	10.17	10.22	10.08	15.79	9.47

*Test could not be completed without errors.

The DOS Disk Access benchmark test measures the time it takes to do a random sector read using DOS. DOS buffers are set at 3 and the interleave factor is set at the drive's default setting. This test adds DOS's overhead to the BIOS and hardware times. The test program performs the sector read 1,000 times within the DOS disk partition. The average result is shown in milliseconds.

The BIOS Disk Seek benchmark test measures the time it takes to do a random seek using the disk's ROM BIOS. The test result includes minimal software overhead and may not parallel the manufacturer's claimed average access time. The test program performs 1,000 seeks. The average result is shown in milliseconds.

The File Access benchmark test measures the time it takes to sequentially create and write a 256K-byte data file using record lengths of 512 bytes and 4K bytes. The test program then performs a series of operations: a sequential read of the same file, a random write, and a random read.

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■ SYSTEM INTEGRATORS

Sysgen Inc.

Sysgen Matched Pair 70

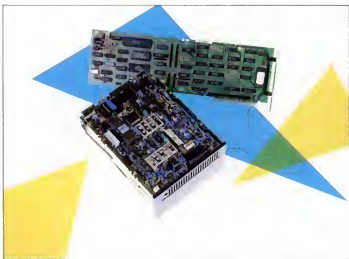
Sysgen's Matched Pair 70-megabyte fixed disk and controller looks like it could be a universal high-capacity package for the IBM PC market. The Matched Pair is designed to work in both the XT and the AT, and the controller card is able to take on a piggyback controller for a streaming tape backup system.

The drive package consists of a full-height 70-megabyte fixed disk, a full-length, standard-height controller card, cables, partitioning software, and an instruction manual.

Installation is straightforward and is helped by a succinct manual—at least if you're installing it on an XT. The manual was written for the XT, and AT installation is handled indirectly in the appendices. AT users should read the manual all the way through and take notes before they start.

An unusual feature for AT users is the fact that the controller card is meant to be installed in the AT as well as in the XT. Doing it right requires moving the AT's own floppy and fixed disk controller over one slot; otherwise, the Matched Pair 70's cables don't have any way to get to the disk drive.

The biggest problem with installa-



The Sysgen Matched Pair 70 hard disk system includes a full-length, standard-height controller card, cables, partitioning software, and an instruction manual. AT users will be surprised to learn that the controller card can be installed in the AT as well as in the XT. To do so, however, requires some complex adjustments to the operating system.

tion—and the manual—is that the PC's operating system has to be modified before it will work with the Matched Pair 70's controller; If DOS 3.10 or later is being used in an AT, it has to be patched. However, this is presented so far back in the manual that if you're following it along, step by step, you'll have to backtrack and redo some of the installation.

Installation on an AT took approximately an hour. Most of that time was spent making the adjustments to the operating system, running Sysgen's BIOS physical format of the disk, and partitioning the disk.

A call to the technical support people at Sysgen was prompted by some confusion on running the physical format. The technician was very helpful and didn't have to search for the answer. Unfortunately, Sysgen made getting in touch unnecessarily difficult by not printing the 800 number in the user's manual.

The Matched Pair 70's disk drive gives the impression of being a good performer. It's quiet, doesn't vibrate, and doesn't make any noise when the heads change

■ The Sysgen drive runs hot. Not hot enough to warn you of a problem, but hot enough to melt circuit chips.

tracks. Its overall performance is faster than IBM's standard for AT drives.

All that was fine, until the circuit board on the bottom melted.

The drive runs hot. Not hot enough to warn you of a problem, but hot enough to melt circuit chips. Running this unit in any personal computer absolutely requires a steady stream of air on all sides of the drive. If the breeze is cut off or even if the drive is run with the cover off the PC, it's likely to fail.

The drive probably shouldn't be in-



FACT FILE

Sysgen Matched Pair 70

Sysgen Inc.
556 Gibraltar Dr.
Milpitas, CA 95035
(408) 263-4411
List Price: \$3,495

Type: 70-Mbyte full-height, 5 1/4-inch hard disk drive with matched controller card for the AT

Includes: 70-Mbyte disk drive, full-length controller card, software, cables, mounting hardware, instruction manual.

Manufacturer: Toshiba. Controller and software by Sysgen

Requires: 192K RAM, XT or better power supply, DOS 3.x or later, full length slot for controller on both XT and AT.

Warranty: 1 year limited.

Warning: A great idea gone wrong. The drive generates far too much heat.

CIRCLE 649 ON READER SERVICE CARD

■ SYSTEM INTEGRATORS

stalled in clones whose hard disk bay has a shelf or any other obstruction that will cut off air to any part of the drive. Somehow, \$3,500 seems too much to pay for a fixed disk you have to blow on just to keep it running.

TANDON CORP.

Tandon TM9262AI (Integrated version) Tandon TM9755AI (Integrated version)

In the world of fixed disk system integrators, Tandon Corp. is unique—a major disk drive manufacturer that has chosen to act as its own integrator. The drives are also available without controllers from



Tandon is the only major hard disk manufacturer that acts as its own integrator, and the results of its scheme are successful. The 40-megabyte TM9755AI drive (right) is named an Editor's Choice for its quiet and efficient operation and its half-length controller card that fits in an XT short slot. The TM9262AI (left) is just as good, though half the size.



FACT FILE

Tandon TM9262AI (Integrated version)

Tandon Corp.
20320 Prairie St.
Chatsworth, CA 91311
(818) 993-6644

List Price: \$685

Type: 20-Mbyte half-height, 3½-inch hard disk for the XT.

Includes: Hard disk, half-length controller card, mounting hardware, half- and full-height faceplates, installation manual.

Manufacturer: Tandon Corp.

Requires: DOS 2.0 or later.

Warranty: 1 year limited from IDE Associates.

In Short: A high-quality, easy-to-install drive.

CIRCLE 846 ON READER SERVICE CARD

EDITOR'S
CHOICE

Tandon TM9755AI

(Integrated version)

Tandon Corp.
20320 Prairie St.
Chatsworth, CA 91311
(818) 993-6644

List Price: \$1,725

Type: 40-Mbyte half-height, 5¼-inch hard disk for the XT.

Includes: Hard disk, half-length controller card, cables, mounting hardware, manual.

Manufacturer: Tandon Corp.

Requires: DOS 2.0 or later.

Warranty: 1 year limited from Tandon.

In Short: It's fast. It's easy to install. It's an AT-level drive for the XT.

CIRCLE 847 ON READER SERVICE CARD

mail-order houses (see "Cut-rate Converters" in this issue).

Tandon apparently has introduced some consumer product practices to the production of its TM9262AI 20-megabyte and TM9755AI 40-megabyte internal fixed disks for the PC-XT. The result is a pair of high-quality, easy-to-install, hassle-free disk drives.

The worst thing you can say about Tandon's TM9262AI 20-megabyte fixed disk is that the box it comes in looks like it should be sitting on a shelf in K-Mart. Don't let that fool you. What's inside is worth a good look.

The half-height drive comes with a half-length controller card that fits nicely in a short slot; it also has cables and a skimpy-looking installation manual. A close look at the drive and the circuit board shows that Tandon put some effort into manufacturing this fixed disk. Everything about it is neat and solid.

The TM9262AI's instruction manual is deceptive. What you get is a sheet that folds out like a map, and that doesn't seem to say very much. The surprise is that's all

you'll need to get the drive up and running without a problem.

Installing this drive and controller is simple. Plug the card in, slide the drive in place, hook up the cables, and then run the DOS FDISK and FORMAT programs. Total elapsed time: about 15 minutes. Tandon saves you a lot of time because it ships the disk drive already low-level-formatted.

In operation the TM9262AI proves that what looked like careful manufacturing wasn't an illusion. It's absolutely quiet: no hum, no vibration. Its running speed doesn't put it in the superstar class, but it's still about 30 percent faster than IBM's standard for XT drives.

The only drawback to this drive is its limited size. Twenty megabytes is really too small to attract someone who wants really high capacity.

Tandon's TM9755AI 40-megabyte fixed disk picks up where its 20-megabyte product leaves off. Same quality construction. Same incredible ease of installation. Same superquiet operation. Same kind of half-length controller card that will fit into an XT short slot.

■ SYSTEM INTEGRATORS

PC EDITOR'S CHOICE

• Tandon TM9755AI

Each of these fixed disks has its own advantages. Both the Sysgen Matched Pair 70 and the Mountain FileSafe (62 MB) are very-high-capacity drives that can be partitioned into a number of virtual disks. The IDE Associates Diskit A30 is a solid AT-level drive that is easy to install. Tandon's TM9262AI and TM9755AI for the XT share the virtues of speed and simple installation.

Our choice is Tandon's TM9755AI 40 megabyte fixed disk for the XT. Comparing XT and AT drives may not be entirely appropriate, but the TM9755AI's combination of speed, capacity, ease of installation, and cost points out what you should be getting in a drive no matter what system it's for.

Only the instruction manual is a little different. It's still sparse and straight to the point, but it comes in the form of a small booklet.

Even partitioning the disk into two virtual drives was simple. All it required was running FDISK and FORMAT for each virtual drive.

The TM9755AI is a fast drive, running more than twice as fast as the IBM standard for XT drives. That gives you the excellent advantage of AT speed and capacity in an XT drive.

The only people who are going to be disappointed in this fixed disk are the technofreaks who aren't totally comfortable unless they have to go through a lot of machine level gyrations to get a piece of hardware to work. As for the rest of us, who would rather use the drive as quickly as possible than memorize manuals, Tandon's TM9755AI is the perfect high-capacity XT disk drive.

Walt Rowinsky is a free-lance technical writer based in Cleveland, Ohio.

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CIRCLE 221 ON READER SERVICE CARD

HALF-HEIGHT ALTERNATIVES:

Cartridge Systems from Iomega and Kodak

One of the basic truths you probably learned in your first years of playing with your PC is that computer disks are either hard or floppy and never in between. According to this theory, hard disks are fast, capacious, and forever locked inside their environmentally controlled chambers. Floppy disks are the opposite—slow, small, and removable. Each has evolved to its own purpose inside your PC, and each has become important to you and your work in its own way—hard disks for on-line storage and floppy disks for exchanging files and backing them up.

Mixing up disk types is not something an enlightened computer person would be likely to do. But two manufacturers, Eastman Kodak Co. and Iomega Corp. have for several years been doing exactly that—combining the qualities of hard and floppy disks and coming up with interesting blends.

Iomega has earned a substantial reputation and a near-fanatical following because of the speed and sturdiness of its Bernoulli Boxes. Kodak, through various divisions, subsidiaries, and spin-offs, has been testing the limits of floppy disk technology, pushing capacities first to 3.3 megabytes, then to 6. No matter what you call these

The advantages of half-height cartridge systems—speed, portability, crash protection, and large storage capacity—make them enticing alternatives to floppy and hard disks. Iomega's and Kodak's products are much improved, but which would suit your needs the best?

■ CARTRIDGE SYSTEMS

products—high-capacity floppy disks, flexible disk cartridges, or some proprietary name—the promises of their mutant technologies include hard disk speed with the portability and crash-free operation of floppy disks.

Although the seeds of this crossbreeding have been successful from the engineering perspective—the products actually work—they have suffered from shortcomings. The first-generation Bernoulli Box was more a Frankenstein than a successful offspring, a monster lovingly sewn together, powerful but unaware of its great mass. The first Bernoullis were bolted together with nearly enough iron to hold a dreadnought against a typhoon.

On the other hand, one reason the 3.3-megabyte Kodak floppy disks never caught on was that they weren't big enough. They quickly lost their luster when comparisons switched from their ten-to-one capacity advantage over conventional floppy disks to their three-to-one edge over the generally unlabeled 1.2-megabyte AT floppy disk drives.

The new products from both companies sidestep those shortcomings. Iomega has cut the Bernoulli down to size, to little larger than an ordinary half-height floppy disk drive. Kodak has packed enough bytes into its super-density floppy disks to nearly regain the ten-to-one capacity lead over even ordinary high-density floppy disks.

As a result, the two organizations are squared off with almost directly competitive products. Both use cartridges of roughly the same size—square plastic shells no larger than a stack of ordinary floppy disks—filled with nearly identical flexible media. Capacities, although hardly identical, are both in the traditional hard disk range—12 megabytes in the case of the Kodak system, and 20 megabytes per Bernoulli cartridge. The disk drive units themselves will fit nearly the same slots in computer disk drive bays.

For all their similarities, however, the two new products have enough differences to make the competition both exciting and meaningful. On one side are greater speed, greater capacity, and a price to match. On the other are more modest capabilities and costs. If one winner emerges from this twosome, it will show where most PC us-

ers place their values—on performance or the pocketbook.

You're unlikely to buy one of these hard disk alternatives wearing the name of its factory. Both Kodak and Iomega aim their products at OEMs (original equipment manufacturers) and systems houses, which are companies that take components, mate them together, test them, and sell them bearing their own names.

The Bernoulli reviewed here came bedecked with the Tandy imprint and is available at your local Radio Shack Computer Store. A similar system is available

■ The Iomega and Kodak products have enough differences to make the competition both exciting and meaningful.

from Mountain Computer. The Kodak remains a few ticks behind in its product cycle and is now being distributed only to OEMs (and to us, of course) for evaluation, but it is intended for exactly the same sort of distribution. In addition, Kodak will sell the disk drive to end users under its Verbatim brand name.

BIGGER BYTE Eastman Kodak Co.'s Verbatim 12-Megabyte Internal Subsystem system appears to be the simpler system—the familiar floppy disk pushed to its limits. The foundation of the Kodak system is standard floppy disk technology—a flexible medium against which a pair of read/write heads physically rest, one on each side. The only apparent difference in the media is that the floppy disk itself is packed inside a tough plastic shell similar to that used by 3½-inch micro floppy disks.

The similarity to conventional floppy disks becomes readily apparent if you slide open the protective metal door on a Kodak cartridge. Inside the plastic shell is the familiar black jacket of the ordinary floppy disk. That's right—except for a special

plastic hub, the Kodak cartridge is just a floppy disk that's been put into a second shell.

To achieve 12-megabyte capacity on that floppy disk, however, Kodak breaks with one aspect of floppy disk design, open-loop head positioning, substituting closed-loop embedded-servo head positioning, a design innovation the company has pioneered in floppy disks. This technique was the hallmark of the original Kodak 3.3 system, which made its first appearance in early 1985.

The Kodak system is based on the concept that the oxide recording medium is not the limit to floppy disk storage capacity. Although big capacities ordinarily require high-quality disks—for instance, with the 1.2-megabyte PC AT floppy disk drive—the major limit on disk storage is the disk drive mechanism. Squeezing ever larger amounts of data into a given disk area—for instance, the surface area of a 5¼-inch floppy disk—requires that individual data bits (or more accurately, flux cells) on the disk be smaller and more closely spaced. The head mechanism of the disk drive must be able to position itself with sufficient accuracy so that it can pinpoint each individual bit.

Conventional open-loop disk drives use stepper motors to move their heads. The control electronics of the disk drive sends a signal to the motor to move the head to a given place on the disk—and hopes that the head moves there. It has no way of knowing for sure where the head actually ends up. Consequently, the precision with which the mechanism is made determines its accuracy and resolution in moving the head.

With enough ingenuity, time, and resources, a disk drive may be built with nearly unlimited precision—but even a military weaned on a \$400 hammer might not be able to afford it. The alternative is to provide some sort of feedback (closing the loop) to tell the control electronics where the head is so that the electronics can compensate for any errors. Most more-expensive hard disks use this technique.

Floppy disks face a problem in implementing closed-loop systems, however. Hard disks have multiple platters, so to devote one platter to nothing but carrying head-positioning information imposes but

■ CARTRIDGE SYSTEMS



The \$1,400 Kodak Verbatim 12-Megabyte Internal Subsystem is based on 5¼-inch technology, but it uses media cartridges ½ inch thick and spins the disk at 600 rpm.

to indicate that the disk drive is receiving a supply of electricity; the other indicates disk drive activity, like the light on an ordinary floppy disk drive.

Normally, you slide a cartridge through the slot against spring pressure. When it gets far enough in, the cartridge pops downward to its normal, in-use position. To retrieve the disk, you press a rectangular push button underneath the center of the drive slot, which releases the cartridge and lets the pent-up spring pressure eject it. The mechanism works instantly—as with ordinary floppy disks, you don't have to wait for the disk to spin down before it will dash out of the disk drive.

Just in case the spring force is not sufficient to propel the cartridge far enough out of the slot, an inset area on the left side of the slot should allow even the fattest fingers to grasp the reluctant cartridge and pull it out.

The top of the disk drive is entirely covered with a printed circuit board, foil side up. The bottom is almost completely covered by a protective metal shell with the large rotor of the spindle motor visible in the middle but slightly recessed. The rest of the mechanism, including the two stepper motors used for head positioning (one for coarse head movement, one for fine, trimming action), is hidden inside.

The disk drive unit uses the SCSI interface and is completely self-contained. It needs only to be plugged into a SCSI host adapter to mate with any PC. The evaluation system supplied by Kodak included a 5-inch-long expansion card that uses the XT 8-bit data bus as a host adapter.

Installing the disk drive requires little more than mounting it in a drive slot like any other floppy disk drive, using tapped screw holes in the conventional position at the sides or bottom of the disk drive. (The Kodak evaluation kit contained drive rails for AT installation.) Plug a power cable and the wide, 50-conductor ribbon cable from the host adapter into the disk drive and you're done.

Both the host adapter and the Kodak disk drive allow some degree of system customization with jumpers (the adapter) and DIP switches (the disk drive), but none of these need to be adjusted to bring the system to life.

The evaluation implementation from



FACT FILE

Verbatim 12-Megabyte Internal Subsystem

Eastman Kodak Co.
Mass Memory Division
343 State St.
Rochester, NY 14650
(800) 445-6325

List Price: \$1,400; media, \$50.

Requires: DOS 2.0 or later.

In Short: A new cartridge mass storage system that's a cross between floppy and hard disks. Although based on 5¼-inch floppy disks, it nearly achieves hard disk capacities and speeds.

CIRCLE 671 ON READER SERVICE CARD

a slight penalty. But floppy disks, by their nature, are singular disks with only two recording surfaces corresponding to their two sides. Using one of them for servo information would mean cutting data capacity of the disk in half—not an entirely satisfactory solution when the initial design problem was to increase capacity.

Kodak uses an alternative method of delivering the information needed by the

disk servomechanism. It embeds it on the same surfaces used for storing data, essentially squeezing it between the data tracks.

The system works quite simply: If the read/write head is properly positioned directly on the data track, it should be exactly in between the two servo bursts that straddle each track. At that point, and that point only, the servo signals from the two tracks will be of equal strength. Whenever the head varies from the data track, one of the servo bursts will be stronger than the other. The disk drive electronics can detect this change and move the head toward the weaker signal to compensate. With this scheme, the position of the read/write head can be controlled to within one ten-thousandth (1/10,000) of an inch, tight enough for multimegabyte floppy disk capacities.

A WIDER SMILE The Verbatim 12 drive looks much like an ordinary floppy disk drive that's widened its smile. The disk slot is about ¼ inch high to accommodate the thicker media cartridges used by the system.

Above the left side of the slot are two red LED indicators. One constantly glows

THE HARD FACTS OF HARD DISK CARD INSTALLATION

What does a nontechnical person learn about computers when asked to install a hard disk card with no help?

The documentation for the Plus Development HardCard claims you can be up and running 30 minutes after you open the box. I timed it: 35 minutes elapsed between the moment I pulled the HardCard out of its plastic wrap to the moment I read the on-screen message, "The hands-off installation of your HardCard is now completed." Not bad.

Installation of this product is a breeze. The 20-megabyte HardCard fits exactly where it should—in one slot. The instructions and illustrations in the manual are straightforward and easy to understand.

The HardCard arrives preformatted. You type one command, **INSTALL**, and let the HardCard do the rest. With no further ado it creates a reinstallation disk (on a floppy disk) and sets up a directory menu with 16 subdirectories.

My one gripe about the HardCard installation procedure is that the hard disk is automatically configured to boot up to the HardCard Directory (HCD)—even if you don't want to use it. Although the manual does contain information on disabling the HardCard Directory, it is listed in the back of the manual only as a technical tip.

I would have preferred an on-screen prompt in the middle of the installation procedure that read, "If you wish to have your hard disk automatically boot to the HardCard Directory, press any key. If you wish the disk to boot to the DOS prompt, hit Esc." Maybe the next HardCard will have this option; it seems to be the only thing missing.

Installing the HardCard in my XT was easy, but getting it to work with my system has not been. If I were to hit Ctrl-Alt-Del right now, I would get a controller error message.

The HardCard manual gets big points for listing all the possible error messages you might encounter, along with a diagnosis of each situation. Sure enough, the manual contains the message that appears on my screen every time I do a warm boot: "1701-Controller error".

After checking the jumper switch on the HardCard (it was in the correct position), hitting the big red switch (which doesn't produce an error message), and reinstalling the disk (it takes only 10 minutes), I still can't do a warm boot.

The technical people at Plus Development couldn't understand what was wrong. Just to be absolutely sure of a

HardCard malfunction they asked that I put the HardCard into another computer—where, by the way, it worked perfectly. So the complications have nothing to do with the Plus Development HardCard and everything to do with my computer. I've consulted all the experts at *PC Magazine*, and for once they are all in agreement: none of them know what's wrong. The latest theory is that my system isn't completely standard—my non-IBM color monitor controller card may be causing the problem.

But I'm not upset. The hard disk card has had an immediate and beneficial effect on my work life. Instead of the 30-some-odd floppy disks that I usually collect and sort through and lose in the course of an issue, I now have 20 megabytes of organized memory. I'm thrilled. And in the course of installing the card, I've learned the biggest difference between a computer novice and an expert. The novice worries that he's done something wrong, while the expert knows that it's all the computer's fault.

—Luisa Simone

Luisa Simone is an executive editor of PC Magazine.

Kodak used an installable device driver that must be listed in the host computer's **CONFIG.SYS** file to make the system recognizable by DOS. No provision was made for booting from the Kodak disk drive.

Once the device driver is installed, the Kodak system works just like any other disk drive. It's recognized by its own drive letter, and most DOS commands work perfectly. The exceptions are **FDISK**, **FORMAT**, **DISKCOMP**, and **DISKCOPY**, which will not work properly with the Kodak system (nor are they designed to).

The Kodak disks are supplied preformatted with their low-level servo informa-

tion already in place. In addition, for DOS (high-level) formatting, Kodak provided a proprietary program. While quite simple to use—it merely queries which drive to format and warns of the damage you're about to do to whatever data might be on the disk—the program is time-consuming and requires nearly a minute per megabyte of cartridge capacity.

QUICK SPIN Compared with traditional floppy disks, the Kodak system is a genuine joy. It responds nearly instantly to commands and feeds data to the computer more quickly than an ordinary floppy disk.

The higher data speed can be attributed

to the faster spin—600 rpm for the Kodak system versus 300 for ordinary floppy disks—and the greater data density that allows it to read more bytes per revolution.

Because the system uses conventional floppy disk technology—the read/write head actually touches the disk surface—it is subject to wear. According to Kodak documentation, the system is supposed to minimize this wear by cruising its head when not in use; that is, the drive motor keeps spinning, but the head moves a few tracks across the disk surface every 15 seconds so no single track receives greater wear.

In addition, the disk drive shuts down

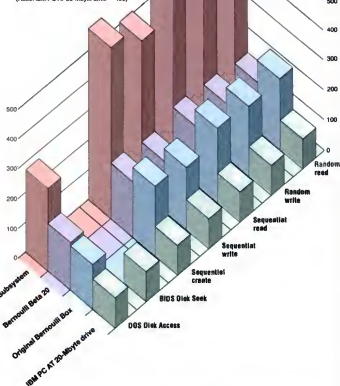


Benchmark Tests: Half-Height Alternatives

With their mixture of floppy and hard disk technology, the products reviewed here are designed more for the convenience afforded by their removable disks and cartridges than for sheer speed. The Verbatim 12-Megabyte Internal Subsystem is basically a big floppy, and its access times reflect that technology. The Bernoulli Beta 20 is much faster, but still not as fast as most hard disks.

Relative Times

(Ratio: IBM PC AT 20-Mbyte drive = 100)



Performance Times

(Times given in seconds except where noted.)

	DOS Disk Access (milliseconds)	BIOS Disk Seek (milliseconds)	File Access				
			Sequential create	Sequential write	Sequential read	Random write	Random read
Verbatim 12-Megabyte Internal Subsystem	119.81	N.A.	53.83	103.36	52.19	97.29	48.57
Bernoulli Beta 20	68.40	N.A.	17.50	34.06	17.26	31.86	17.03
Original Bernoulli Box	64.59	N.A.	21.97	42.33	21.86	40.79	24.66
IBM PC AT 20-Mbyte drive	43.50	37.35	9.39	20.36	8.73	17.30	10.25

N.A.—Not applicable; these products do not have BIOS drivers.

The **DOS Disk Access** benchmark test measures the time it takes to do a random sector read using DOS. DOS buffers are set at 3 and the interleaving factor is left at the drive's default setting. This test adds DOS's overhead to the BIOS and hardware times. The test program performs the sector read 1,000 times within the DOS disk partition. The average result is shown in milliseconds.

The **BIOS Disk Seek** benchmark test measures the time it takes to do a random seek using the disk's ROM BIOS. The test result includes minimal software overhead and may not parallel the manufacturer's claimed average access time. The test program performs 1,000 seeks. The average result is shown in milliseconds.

The **File Access** benchmark test measures the time it takes to sequentially create and write a 256K-byte data file using record lengths of 512 bytes and 4K bytes. The test program then performs a series of operations: a sequential read of the same file, a random write, and a random read.

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You'll call it a lifesaver.

Between Applications

Smart includes the full range of productivity applications your office needs: Word processing, data base management, spreadsheet analysis, business graphics, and communications.

All perfectly integrated for easy transfer of data from one application to the next.



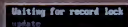
And only Smart lets you create custom programs that actually jump between applications. So, for instance, a single keystroke can transform a worksheet into a 3-D pie chart, paste the chart into a document, and send the document via modem to the home office.



Smart's "REMEMBER" command lets non-programmers create custom programs.



Smart's "SEND" command makes it easy to move data between applications.



Smart automatically updates and data in multiple environments.

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There are even versions of Smart for multiuser UNIX® systems.

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Between Software Brands

Old software can be replaced, but old data can't. So you'll be pleased to learn that Smart is fully compatible with files already created with programs like Lotus 1-2-3 and dBase III Plus.

Smart also reads and writes ASCII, SYLK, DIF, and DCA.

Oh by the way, there's something else Smart is perfectly compatible with: You. Fact is, nearly every top computing magazine has praised Smart for its ease of use, on-line help, extensive tutorials, and clearly written manuals.

But why not see for yourself?

Just return the attached card, or call toll-free (800) 331-1763 (in Kansas, Alaska or Canada call (913) 492-3800) and we'll rush you a free Smart demo disk and information kit.



SmartWare
from Innovative Software



■ CARTRIDGE SYSTEMS

after a minute and a half of inactivity, the same way a floppy disk drive does. Unlike floppy disk drives, however, when the motor shuts down, the head retracts to a reserved track at the outer edge of the disk. When the disk drive motor comes up to speed, the head travels to a requested sector almost instantly upon receiving a DOS command.

With the evaluation unit, the 1 second or so wait that we've become accustomed to when using a floppy disk was gone. Responses seemed nearly like that of a true hard disk.

In performance tests, the Verbatim 12 shows how archaic floppy disks really are. Compared with hard disks, however, it's a leisurely worker. It took its time when confronted with the challenge of reading and writing large files, moving data at a rate somewhat greater than 2 megabytes per minute. Its average access time, although not readable through hardware-dependent test software, appeared in the range of 110 to 120 milliseconds. That's near the bottom of the hard disk range, about 30 percent slower than an XT disk drive.

Perhaps the biggest surprise we encountered occurred when trying to write a 10-megabyte file to one Verbatim 12 disk—the 12-megabyte capacity that Kodak promotes is *unformatted storage*. Format a Kodak disk and it can hold only about 9,960,000 bytes, less than 10 megabytes.

The Kodak system implements several additional interrupts that may conflict with nonstandard interrupts used by non-IBM hardware and software. For example, when we tried it on a Tandy 3000 HL system, the computer reported receiving unexpected software interrupts when attempts were made to access the disk drive, causing the system to crash. No such interactions were observed with a PC's Limited AT compatible, however. If you're using a compatible, our advice is to try out the unit on your computer before you buy.

DOWNSIZEING DRIVES While Kodak has been busily building things bigger, Iomega Corp. has been working in the opposite direction, bundling the behemoth Bernoulli Box into a more manageable package, the Bernoulli Beta 20. A capacity that once required disk drive units that ri-

valued an AT in stature now fits comfortably in the same space as an ordinary disk drive.

If you haven't been initiated into the cabala of the Bernoulli, the name is derived from the Bernoulli theorem, first proposed by the 19th-century Swiss mathematician and physicist Daniel Bernoulli. In essence, the theorem states that the faster a fluid moves, the lower its pressure. The lower pressure achieved by high-velocity fluids gives airplane wings their lift and helps the sails of a boat pull it along. It also lifts the head of a conventional hard disk drive a few micro-inches above the disk surface.

In the Bernoulli box, the air pressure flexes the thin plastic disk used inside the cartridges around the read/write head. As a result, the heads of a Bernoulli disk drive are like those of a conventional hard disk in that they do not touch the disk. Because of this lack of physical contact, the Bernoulli disk can be spun much faster (which lets it transfer data faster) and is less likely to wear out.

The original Bernoulli Box required a full-height (about 5 inches), 8-inch form-factor drive slot and held only 10 mega-

bytes. For PCs, that meant connecting an expansion box about the size of a second system unit.

The first spate of Bernoulli miniaturization squashed that disk drive down to half its size but still left it too wide to fit into a PC system unit. An increase in storage density pushed capacity to 20 megabytes per cartridge.



FACT FILE

Bernoulli Beta 20

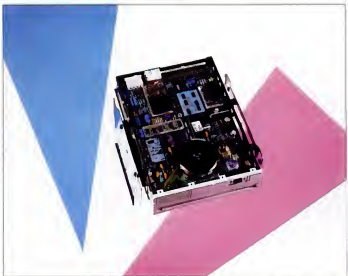
Iomega Corp.
1821 W. 4000 South
Roy, UT 84067
(801) 778-1000

List Price: As Mountain Beta Bernoulli,
\$2,195; media, \$140. As option to Tandy
equipment, \$1,799; media, \$84.95.

Requires: DOS 3.0 or later.

In Short: This new, 5¼-inch mass storage system is a clever alternative to a conventional hard disk. It stores more and operates faster than Kodak's model, but it is much more expensive as well.

CIRCLE 679 ON READER SERVICE CARD



The Bernoulli Beta 20 (pictured here as removed from a Tandy 3000 HL AT-compatible system) stores more and works faster than the Kodak Verbatim 12.



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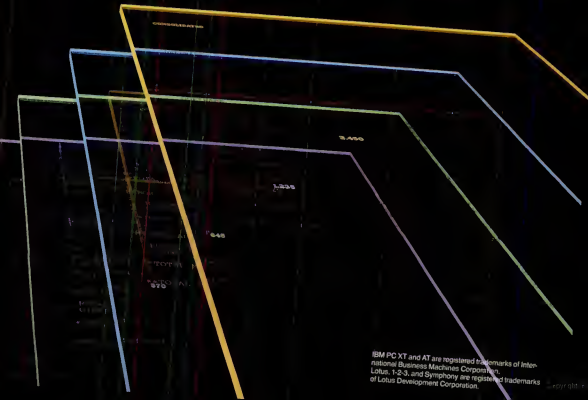
The multi-user version supports Local Area Networks. As many as 32 users can access the same spreadsheet at the same time, with separate security levels for each. Right down to the cell. The system administrator has full control and can match task and security requirements to each user.

You can automatically import 1-2-3® and Symphony® files directly — formulas, macros and all. Boeing Calc's command structure works like Lotus® and permits you to move quickly to its more efficient command option.

For a demo diskette and the nearest dealer, call 1-800-551-0800, Ext. 12. Or write Boeing Computer Services, P.O. Box 24346, M/S 7W-05, Seattle, WA 98124-0346.

BOEING

CIRCLE 129 ON READER SERVICE CARD



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■ CARTRIDGE SYSTEMS

With the most recent downsizing, the Box is finally manageable. Amazingly, none of its hard-earned capacity is sacrificed. The smaller cartridges hold the same amount of data as their predecessors, nominally 20 megabytes.

While the Bernoulli disk drive itself fits a half-height drive slot, the system also requires a proprietary controller board that's as wide and deep as the drive and steals about half an inch of extra space somewhere. Normally, this controller, which can operate up to two Bernoullis, will be attached to the bottom of the disk drive unit. Even with it so attached, the little Box will easily fit into the lower-right-hand slot in an AT.

The Iomega system also requires a 5-inch-long host interface adapter card that slides into an 8- or 16-bit expansion slot to adapt the PC bus to the SCSI connection favored by the Iomega controller. A set of jumpers on the host adapter card allows setting the base address of the ROM firmware used by the system. Jumpers and a DIP switch on each Bernoulli disk drive allow selection of its SCSI address and logical unit number.

About the only penalty imposed by the size reduction of the new Bernoulli is incompatibility with older cartridges. If you already have one or half a dozen older Bernoullis in your office, you won't be able to exchange disks with the new system, unless you can defy physical reality by sliding an 8-inch-wide cartridge into a 5½-inch slot. Then again, the new 5-inch disks are so convenient, you probably wouldn't want to.

As delivered with the Tandy name, the small Bernoullis are finished in beige to match the color scheme favored by IBM for its AT and Tandy for its compatible 3000 series. The front panel of the disk drives is cleverly styled, with a series of horizontal grooves that make the functional elements an inherent part of the design concept.

Near the bottom of the front panel, a wide swinging door covers the disk drive slot. At its upper right is a push button and two LED indicators. At its upper left is a ventilation grille that can be removed to help you pry out cartridges should they become jammed.

In normal operation, you just slide a

cartridge in until it stops, with the front edge protruding out of the slot about ½ inch. The disk drive motor immediately and automatically starts spinning. Until it reaches speed, one LED flashes. When the disk is ready, this indicator glows continuously. The other LED flashes with disk access.

Removing a cartridge requires pressing the release button and waiting for the disk to spin down. The cartridge is safely

■ If you already have older Bernoullis in your office, you won't be able to exchange disks with the new system.

locked in place until the disk stops. Then the lock is released, and you must pull the cartridge out of the slot.

QUICK RUN Once the Iomega hardware is installed, it's simple to get running. Although the Iomega system in its Tandy implementation requires the use of a device driver loaded through the host system's CONFIG.SYS file, its firmware allows the computer to boot from a Bernoulli disk drive.

The Bernoulli cartridge evidently has its low-level format in place when delivered but must be DOS-formatted before use. The process is amazingly quick, requiring only about 12 seconds. After that, the Bernoulli performs like an ordinary disk drive using standard DOS functions (except for FDISK, FORMAT, DISKCOMP, and DISKCOPY, as with the Verbatim 12).

The original Bernoulli Box earned a reputation for speed. The big drives were able to move information faster than ordinary PC hard disks because they used a higher data transfer rate—8 MHz for the Bernoulli versus 5 for normal hard disks.

Along with the size reduction of the new Bernoulli has come a slight performance reduction. Its data transfer rate is

nominally 5.33 MHz (a misprint in the Tandy manual credits it with being eight times faster—5.33 megabytes per second). At 1,835 rpm, the Bernoulli disks spin at roughly half the rate of ordinary hard disks, but make up for it with twice as much information on each track. Thus, despite its 8-bit interface, it can transfer data at nearly the same pace as a high-performance AT hard disk (when installed in an AT, of course).

Because the system is incompatible with direct hardware commands (as opposed to those made through DOS or the system BIOS), its average access time is difficult to measure. Performance in accessing multiple short, scattered records indicates that it is nearly as fast, but not quite, as a standard AT hard disk drive.

Although the Bernoulli head does not touch the media, the constant flexure of the disk does cause it to wear out. Earlier Bernoulli disk drives received some slack because the documentation listed an estimated life span of hundreds of hours for the typical cartridge.

Iomega seems to have eliminated the publicity problem by omitting mention of cartridge life in its current documentation. To extend media life, however, the system retracts the read/write head (with a resounding thud) after a short period of inactivity. Reloading the head causes a slight delay for subsequent disk accesses, but it's short enough to be bearable.

CLEVER ENOUGH Both Kodak's Verbatim 12 and Iomega's Bernoulli Beta 20 disk drives earn high marks as masterpieces of engineering prowess. Either appears fully capable of substituting for a hard disk as a primary storage medium. The speed and capacity of each system are a good match for those of typical PC hard disks.

Moreover, any removable media system has a lot to recommend it over nonremovable systems like hard disks. For instance, its storage capacity is essentially infinite. Should you fill up a cartridge, you need only to pull it out and shove another one in. Removable media can be secure, too, because you can lock your cartridges away in a safe place.

Both of these qualities help make the Iomega and Kodak systems excellent



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HARD DISK CARDS REVISITED

Prices have dropped on these hard disk cards since we reviewed them in February.

PC and XT owners who want to upgrade their systems without buying a full-size hard disk drive have been turning to hard disk cards. Capable of being slid easily into an expansion slot, these intricate examples of miniaturization offer a simple way to get a mass storage boost.

Last February, we looked at the latest wave of hard disk cards ("Sliding in Memory: 14 Hard Disk Cards," *PC Magazine*, Volume 6 Number 3). If you're a PC user in search of hard disk convenience, one of these products may be just what you're looking for, especially now that many prices have dropped—some more than \$200—since these reviews first appeared.

Basic Time Hardpack

The 20-megabyte Basic Time Hardpack is the only short hard disk card in this group. Although the package is almost three slots thick, it is designed to go into slot 5 of a PC or slot 7 of an XT to make the most of available space.

The controller, built around the Western Digital chip set is tucked beneath the drive itself, which is manufactured by Tandon.

In PC Labs benchmark testing, the Hardpack was among the slowest of the 20-megabyte cards, but if its unique design seems right for your system, the card's just-adequate performance should not deter you from considering it.

CMS Drive Plus 21

Because the disk drive on the CMS Drive Plus 21 is mounted in the middle of the card, this unit will fit into a single slot only if slot 1 is used. Otherwise, it will take up two slots.

The Tandon drive in the Drive Plus 21 performs modestly, but its heads do not

automatically park and lock when the drive is turned off. Electricity consumption is frugal: the card requires only 10 watts.

Installing the card is a breeze, with no jumpers or switches to set. No software is supplied with the card, and no drive activity indicator is provided.

Express Systems 2060, 3060, and 6060

Express Systems offers a wide range of hard disk cards, all based on the same mounting hardware and the same model of 3½-inch hard disk: a La Pine Technology Titan 3532 with a nominal 20-megabyte capacity.

The ever-larger capacities of the cards are achieved through increasing sophistication. The 2060 is based on an SMS OMTI 5510 controller, which uses MFM data coding. The 3060, which uses RLL for greater capacity, has a 7.5-MHz transfer rate. The 6060 adds a second drive to the single drive 3060 chassis, making it so wide that it takes up three slots. This storage for slots trade-off may or may not be worth it. The single drive units require one and a half slots.

Don't count on using the 6060 in an unmodified PC, either. Although the two smaller cards use a normal amount of power, the 6060 swallows a full 24 watts—nearly half the output of a PC. All three models tap part of their electrical needs directly from the host system's power supply through a short adapter cable that is supplied.

In general, as capacity increased, performance decreased in testing. Nevertheless, all the Express Systems cards were on the fast side of average. All three are workable additions to any system, but the usefulness of the 60-megabyte version is doubtful.

I²Card 20 and 30

I² Interface's two hard disk cards promise but don't deliver high performance. The 20-megabyte version is built around a Tandon 362 drive and SMS OMTI 5510 controller, while the 30-megabyte card combines a La Pine Technology Titan 3532 drive with an SMS OMTI 5527 controller, which uses RLL to push its capacity up to 32 megabytes.

In both cases, the 3½-inch drive and controller are screwed to the right side of the mounting so that the card takes up two slots in a PC and three in an XT.

Despite claimed performance enhancements, neither card stood out from the pack on any PC Labs benchmark test. In fact, the 20-megabyte card was among the slowest tested, and the 30-megabyte model was just about average.

Considering this performance, along with a price tag on the high side and a tendency toward power hungriness, the I² cards hardly approach the promises the company makes for them.

Maynard Onboard 10, 20, and 30

Maynard Electronics's three hard disk cards are a true family, differing only in the hard disk on which they are based. All share the same software, controller, and mounting scheme.

All three models take up one and a half slots in a PC or XT, but Maynard provides a special plan for mounting an Onboard in a single slot. To do so requires moving the speaker from its normal position, and Maynard supplies the necessary extension wire as standard equipment. But if you buy a hard disk card for its ease of installation, this is not the kind of thing you're going to want to put yourself through.

The Onboards come with software

that allows you to specify in which corner of your monitor you'd like a visual disk activity indicator to appear. Unfortunately, this feature caused some problems during testing of the 10-megabyte version. When the indicator was turned off and tests were run, the system crashed. On the other hand, the other two models

actually speeded up when the indicator was turned off.

Since our last review, Maynard has begun bundling its Surprise! turbo board with all three versions of the Onboard and has dropped prices significantly.

Maynard doesn't specify power consumption for its cards, but when any of

them were running in a standard PC, head activity caused a perceptible quaking of the display, a sure sign that the system was close to the danger point. Overall, the Onboards make a worrisome addition to a PC.

Mountain Computer DriveCard 30

Amid most hard disk cards, which are little more than mounting brackets, the 30-megabyte Mountain Computer DriveCard 30, which takes up one and a half expansion slots, stands out as a polished, well-integrated product.

Although its RLL controller imposes a compatibility penalty, the DriveCard was consistently one of the fastest cards tested by PC Labs. An idle mode reduces the power consumption of the card from 13 to 8 watts when the card is not in use.

In addition to an installation program, Mountain includes several utilities with the DriveCard. One of the most-valuable ones parks the hard disk heads to prevent damage during shipping. Another utility is used for DOS formatting of the DriveCard. If the last iota of speed matters most to you, the DriveCard may be your best choice.

Plus Development HardCard 20

This is the card that started it all, but Plus's HardCard 20 shows no signs of age. In fact, among all the cards reviewed here, it was named Editor's Choice for its high quality and fine performance.

Since its introduction, the HardCard has been refined and modified so that now it draws only 8 watts of power and is the sleekest and skinniest hard disk card available—the only one that truly takes up only one slot.

The HardCard is a good performer although it slows noticeably when accessed through DOS. It is aimed at the inexperienced user, and its attention to

(continued)



FACT FILE

Basic Time Hardpack

Basic Time Inc.
3040 Oakmead Village Dr.
Santa Clara, CA 95051
(408) 727-0877
List Price: \$369

Requires: DOS 2.0 or later.

CIRCLE 659 ON READER SERVICE CARD

CMS Drive Plus 21

CMS
3080 Airway Ave.
Costa Mesa, CA 92626
(714) 549-9111
List Price: \$695

Requires: DOS 2.0 or later. Drive Plus 21 will not accommodate a second hard disk drive in the system

CIRCLE 658 ON READER SERVICE CARD

Express Systems 2060

Express Systems 3060
Express Systems 6060
Express Systems
1254½ Remington Rd.
Schaumburg, IL 60196
(312) 882-7733

List Price: Express Systems 2060, \$595; 3060, \$795; 6060, \$1,095

Requires: DOS 2.1 or later.

CIRCLE 657 ON READER SERVICE CARD

iCard 20

iCard 30
i² Interface Inc.
21101 Osborne St.
Canoga Park, CA 91304
(818) 341-7914
List Price: iCard 20, \$595; iCard 30, \$650

Requires: DOS 2.0 or later.

CIRCLE 656 ON READER SERVICE CARD

Maynard Onboard 10

Maynard Onboard 20
Maynard Onboard 30
Maynard Electronics
460 E. Semoran Blvd.
Casselberry, FL 32707
(305) 331-6402

List Price: Onboard 10, \$495; Onboard 20, \$895; Onboard 30, \$995

Requires: DOS 2.0 or later.

CIRCLE 655 ON READER SERVICE CARD

Mountain Computer DriveCard 30

Mountain Computer Inc.
360 El Pueblo Rd.
Scotts Valley, CA 95066
(408) 438-6650
List Price: \$995

Requires: DOS 2.1 or later.

CIRCLE 654 ON READER SERVICE CARD

Plus Development HardCard 20

Plus Development Corp.
1778 McCarthy Blvd.
Milpitas, CA 95035
(408) 946-3700
List Price: \$895

Requires: DOS 2.0 or later.

CIRCLE 653 ON READER SERVICE CARD

Standard Brand Flash Card-20

Standard Brand Flash Card-30

Standard Brand Products
CompaqAdd
12303-G Technology Blvd.
Austin, TX 78727
(512) 250-1489
List Price: Flash Card-20, \$429; Flash Card-30, \$495

Requires: DOS 2.0 or later. Recommend 256K RAM on motherboard for IBM PC; recommend power supply upgrade from 130 to 150 watts if installed with internal modem and 640K RAM on IBM PC; not recommended for Compaq computers made before 1985.

CIRCLE 652 ON READER SERVICE CARD

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■ CARTRIDGE SYSTEMS

(*"Hard Disk Cards Revisited" continued*)

detail bears out this philosophy. The documentation is slick and clearly written, and installation is extremely simple. A DOS shell is even supplied to make navigating the new hard disk territory easier.

Standard Brand Flash Card-20 and Flash Card-30

These simple combinations of disk and controller on an aluminum bracket do nothing to hide their origins. The controllers are factory-standard Western Digital products; the 20-megabyte disk, a La Pine technology Titan; the 30-megabyte disk a Miniscribe.

Both systems require one and a half slots (a short card can nestle in the space adjacent to the drive), and both require a direct connection to the computer's power supply.

Despite (or perhaps because of) its simplicity, the Flash Card-30 was one of the fastest drives tested by PC Labs. Its little brother performed well, too. In fact, both drives were good enough to be named low-cost Editor's Choices. At \$429 and \$495, Standard Brand's Flash Cards are one of the most inexpensive—and one of the simplest—ways to get hard disk power in your PC.

—Donald P. Willmott

Donald P. Willmott is an editorial assistant at PC Magazine.

choices for backup in addition to (or in lieu of) primary storage. Their relatively large capacities mean that you need only a few cartridges to back up most hard disks and that you need not shuffle a dozen floppy disks in and out of the disk drive slot. Because these systems are also generally faster than floppy disks, they can cut your backup time. Unlike DOS BACKUP or most streaming tape backup systems, both the Kodak and Iomega disk drives can also execute the files you've backed up.

These cartridge systems are better than ordinary hard disks in another significant way. They both eliminate the big bugaboo of the conventional hard disk by making

■ These systems
eliminate the big bugaboo
of the conventional hard
disk by making head
crashes nearly impossible.

head crashes nearly impossible.

For Kodak, crash protection is a simple matter. The heads in their system can't crash down because they are already sliding across the disk surface.

For Iomega, the physics of the moving system eliminate the danger. Because the thin plastic spinning disk of the Bernoulli system is less massive than that of a conventional hard disk, should some shock or jar send the disk crashing onto the head (the Bernoulli design in fact turns everything upside down so you risk a disk crash rather than a head crash), less damage is likely to result.

In both systems the thin, lightweight disks earn less inertia, are less likely to crash, and are less likely to do damage or be damaged if they do.

On the other hand, both systems use nonstandard, proprietary media. Cartridge supplies may be limited or expensive. If you choose one of these systems and it fails to catch on generally, you might be stuck with an orphan disk drive.

These systems seem expensive, too, compared with the cost of conventional technology. At nearly \$1,800, a 20-megabyte Bernoulli looks like no bargain when compared with a similar-size hard disk selling for \$400. That goes for the Kodak, too, with its \$1,400 price tag.

Should you decide that the advantages of removable media outweigh the expense, the better of this twosome is definitely the Bernoulli. Although the Kodak system is very good, the Iomega is faster and can store more. But it's also much more expensive.

Winn L. Rosch is a contributing editor of PC Magazine.



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An architect in Chicago uses over 40 Bernoulli Cartridges a year archiving lengthy architectural designs generated on a CAD system. Using a Bernoulli Box gives

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A utility company in one Western city uses CAD software and Bernoulli Boxes to keep track of power and water lines. The company has divided the city into quadrants, storing the utility mapping for each quadrant on a single cartridge.

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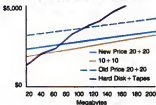
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HOW TO HANDLE YOUR HARD DISK

We've said it before—the single most important productivity enhancement for most users is a fast hard disk. A hard disk gives you instant access to all your files, speeds up operation dramatically, and makes "disk full" errors a lot less common. Floppies are how new software products are packaged, and how you back up your files (unless you own a tape drive or Bernoulli Box). They're also for the birds.

Hard disks used to be expensive and unreliable. That's all changed. Today they're inexpensive and unreliable. I've replaced seven hard disks over the past 3 years, and have to perform tedious daily ministrations to keep my current one purring.

Even the most expensive hard disks are frail and transitory. Many users wedge PC ATs into floor stands beneath their desks, which is fine until they start playing knee-hockey with their systems. Others blithely slide working XT's back and forth across their desks to make room for paperwork, or routinely lift a corner of the chassis to retrieve something that may have burrowed beneath it.

You've all probably seen versions of the illustration in Figure 1, where a human hair, a smoke particle, and even the greasy schmutz of a fingerprint seem enormous compared to the gap between the magnetic head of a hard disk and the rotating disk

*Painless techniques that give you total mastery
over your hard disk—and turn it into a true power tool.*

■ HARD DISK ORGANIZATION

platter itself. With tolerances slightly above the angstrom level, dropping a chasis a quarter-inch, or tapping it with your toe, is the hard disk equivalent of an atom bomb going off directly overhead.

It's true that the packages like *The Norton Utilities* and *Mace Utilities*, and even the pathetic DOS RECOVER command, can rescue parts of text files that remain intact after a bounced magnetic head has plowed little oxide furrows into the disk surface. But these programs aren't very good at resurrecting program files or chunks of data stored in binary format. And when you see a message like

General Failure error reading drive C
Abort, Retry, Ignore?

well, that's what backups are for.

If you set up your hard disk properly, you'll not only take the anguish out of daily backups, but you'll also end up working a whole lot smarter and more efficiently. While you'll have to learn how to handle subdirectories, the tips and utilities we provide in this article should make it a breeze.

If you don't like the do-it-yourself method, buy one of the programs reviewed in our DOS shell roundup (*PC Magazine*, Volume 6 Number 4) such as *X-Tree* or *AirWorks* or *DOS2ools*, or pick up the new *Norton Utilities* 4.0, all of which help you navigate through your subdirectories. But once you learn the basics, you'll be able to solo with the best of them.

COLD START Dealers nowadays test and set up hard disks before shipping them to purchasers. Unfortunately, they also usually follow the truly rotten advice in the DOS manual and copy all the files from the master DOS disks onto the root directory. For best performance, if you log into a brand new hard disk, type DIR, and see the listing scroll off your screen, you should clean things up. But you can't just erase or move all the files there; we'll tell you which ones have to stay in a moment.

If your dealer or MIS department didn't set up your system, and you have a single 30-megabyte or smaller hard disk, it's fairly straightforward.

(If you have an AT that no one has touched, and all you see when you try to start is a "161—System Options Not Set" message, hunt for the SETUP program,

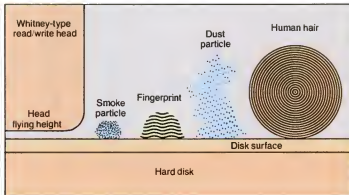


Figure 1: Relative size of assorted dirt and pollutants, compared with the smaller gap between a typical hard disk and its floating magnetic read/write head.

which IBM perversely buried on its AT Diagnostics disk. Put this disk in drive A:, turn the computer on, hit F1 when prompted, and answer the questions about date, time, hard disk type, floppy disk type(s), and memory size. If you need to know the drive type, check to see that it's not in the documentation that came with your system. Then take the cover off and look for the number on the label on the front of the drive. Then call your dealer.)

■ You can slice up a standard hard disk into as many as four partitions and jump from one to the other by using FDISK, but you really don't want to.

Once the SETUP program has run, insert your DOS disk in drive A: and turn your system on. Hit the Enter key twice when asked for the date and time. Type in

FDISK

and hit the Enter key, and when you see the

"Fixed Disk SETUP Program" screen, accept the defaults by hitting the Enter key again to create a DOS partition, and then once more to tell the program you want to devote the entire hard disk to DOS.

You can slice up a standard hard disk into as many as four partitions and jump from one to the other by using FDISK. Take our word for it, unless you're adventurous and have a penchant for dabbling in other operating systems, you really don't want to.

After you've answered the partitioning questions, hit any key and your system should reboot. This time, unless you're using an AT with a battery-operated clock, enter the correct date and time when asked. Assuming you're installing your first 30-megabyte or smaller hard disk in an XT or AT, type

FORMAT C: /S/V

and, if necessary, verify that you want to proceed by entering Y.

The /S suffix or "switch" tells DOS you not only want to format the hard disk, but want to add the three "system" files—IBMBIO.COM, IBMDOS.COM (or their non-IBM-specific cousins), and COMMAND.COM—to it so you can boot without having to stick a DOS floppy disk in drive A:.

If you forgot to add the /S, or if your system is delivered with a hard disk that's been FDISKed and formatted but without these three system files, turn your system

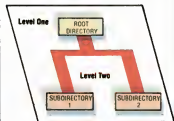
on with your main DOS disk in drive A:, enter the correct date and time information, and then type

```
SYS C:
COPY COMMAND.COM C:
```

The /V switch tells DOS to let you add a volume name. This doesn't really do much except let you personalize your directory listings and CHKDSK reports, and avoid the pesky "Volume in drive C has no label" messages. With recent versions of DOS you can always go back and use the LABEL command to add or revise the volume label.

It's becoming common to add additional hard disks, especially monstrous ones that hold vastly more than IBM's original issue 10s, 20s, and 30s. Current DOS versions limit individual drives to a maximum of 32 megabytes. Manufacturers of larger hard disks usually add small driver programs to get around this restriction, and DOS 3.3 makes it easy.

DOS FAMILY TREE Many users who are either lazy or befuddled by the terse explanation of subdirectories in the DOS manual end up dumping all their files into the main, or "root," directory. It's called a root directory because all other subdirectories branch off of it in a shape vaguely resembling an inverted tree, or more accurately, a family tree (with the progenitor planted at the top and all the descendants fanning out beneath him). An absurdly simple representation would look like this:



You could obviously make the tree much more complex, with third, fourth, and fifth levels dangling below the second, each one bristling with additional subdirectories. Too few subdirectories and you end up with unmanageable numbers of files in each; too many and you can run

into PATH problems (more about those difficulties later).

The schematic representation of your subdirectory structure doesn't have to be in the form of a symmetric tree. An equally valid way to describe the above setup is

```
- ROOT --+ SUBDIRECTORY #1
          |
          +- SUBDIRECTORY #2
```

The root of the tree is at the top, so it's really an upside-down tree. A lower level is one farther away from the root. As you go higher in the tree, you get closer to the root. This sounds confusing, and it is. Just be thankful that IBM didn't choose Unix instead of DOS.

IBM's XT and AT hard disks (which, in its typically contrary way, IBM calls "fixed" disks because they're fixed in place and not removable like floppies) can hold between 10 and 30 million characters; those from other manufacturers can squirrel away as many as half a billion. With storage space so capacious, keeping similar files grouped together is a necessity. Otherwise, you (and DOS) would have to sort through hundreds or thousands of files each time you wanted to find a single program to run.

Just as you can't be at two places at the same time (unless you have a good lawyer), DOS lets you log into only one subdirectory at a time. When you first boot up, DOS logs you into the root directory of either your hard disk or the diskette in drive A:. If you (or your dealer) installed the necessary DOS system files on your hard disk, and if you either didn't have a floppy disk in drive A: or had one there but left the drive A: door open, you'll boot off the hard disk. If this doesn't happen, it's probably because you have either some bizarre Brand-X hard disk or a PC-1 with an old ROM chip that doesn't understand hard disks.

BARE ROOTS You really need only three files in your root directory:

```
COMMAND.COM
AUTOEXEC.BAT
CONFIG.SYS
```

Actually, a root directory formatted with the /S/V option will contain two addi-

tional, "hidden" files, IBMBIO.COM and IBMDOS.COM (or Microsoft's generic versions of these), plus the volume label (which is also stored in a small hidden file). They're called hidden files since they won't show up in normal directory searches. But they're there, and you can see at least the system files at the top of the list when you type

```
CHKDSK C:/V
```

IBMBIO.COM contains additions and corrections to the gut-level device-handling BIOS routines that come with your system on ROM chips. IBMDOS.COM provides other fundamental services for things like copying and deleting files, searching through the directory, or reading the keyboard.

COMMAND.COM is the primary command interpreter, processor, and loader that watches what you type at the DOS

■ COMMAND.COM

is the primary command interpreter, processor, and loader.

prompt. When it sees you trying to execute "internal" commands such as DIR, TYPE, RENAME, COPY, or ERASE, it can dispatch these right away, since the main routines for these are stored inside COMMAND.COM (which is why they're called internal commands). When it can't find an internal command to match what you typed—such as FORMAT, or SORT, or I23—it looks in a set of directories you specify (called a PATH) for files with .COM, .EXE, or .BAT extensions, and tries to load or execute these external commands. In addition, a disposable part of COMMAND.COM looks for the startup AUTOEXEC.BAT file and executes it right after bootup if it finds one.

Every hard disk system should have an AUTOEXEC.BAT file, if only to set the proper system PROMPT. But it's also handy for loading resident "pop-up" programs like SideKick into memory, chang-

■ HARD DISK ORGANIZATION

ing screen colors, setting operating modes (to switch monitors or specify communications protocols, for instance), copying files into RAMdisks, and otherwise automatically configuring your system the way you like it.

Actually, AUTOEXEC.BAT doesn't have to be located in the root directory, and doesn't even have to have a .BAT extension, even though it's a batch file. (See sidebar "Booting Up With BERNIE.")

The normal DOS hard disk prompt is a cryptic

C>

which tells you only that at that moment DOS recognizes drive C:—rather than the others in your system—as the active drive. Once you start creating subdirectories and jumping around from one to another, you'll want to know which subdirectory you're currently logged into. By issuing the command

PROMPT \$PSG

you'll tell DOS to report the name of the subdirectory along with the drive that's active, each time you finish executing a command or program. The root directory prompt will change to

C:\>

The solitary Backslash is DOS's shorthand for indicating the root directory. If the Backslash-Greater-Than-Sign combination is too visually jarring, you could adapt the prompt to

PROMPT \$P:

which will make the root directory appear on-screen as

C:\

Remember, the `\` sign all by itself stands for the root directory. You can always see what's in the root directory, for instance, by typing

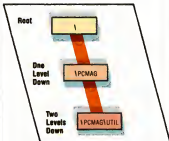
DIR \

Later, when you add other subdirectories, you'll wrap subdirectory names and their files with \ characters. So a subdirectory called PCMAG that's one level down from the root directory would actually be called \PCMAG. And if you were to branch an additional subdirectory off of

\PCMAG and call it \UTIL, the actual name of this new subdirectory would be \PCMAG\UTIL. A file called TOOLS.DOC in this new subdirectory would actually be called \PCMAG\UTIL\TOOLS.DOC.

One of the handiest but most confusing aspects of naming files in subdirectories is that you could pepper your hard disk with other **TOOLS.DOC** files. So a **TOOLS.DOC** file on drive C: in the **\PC\MAG** subdirectory would really be **C:\PC\MAG\TOOLS.DOC**, while a different version in the root directory would be **C:\TOOLS.DOC**. The full name of any file has three parts: drive letter, path, and the actual filename-plus-extension.

A representation of this structure looks like this:



The root directory doesn't have a user-defined name such as PCMAG, so DOS designates it as just \ with nothing following it.

The PROMPT command can do all sorts of tricky things, such as reporting the time and date or the DOS version. If you ask it to, it will print the current time whenever you do something that summons another DOS prompt, such as hit the Enter key again or finish executing something. It will not act as a clock and display the continuously changing time. And it will display time in hundredths of seconds based on a 24-hour clock. If you want it to print just the hours and minutes and nothing else, you can backspace away everything else with the command

PROMPT It's now \$T\$H \$H\$ \$H\$ \$H\$ \$H\$ \$H\$ \$H\$ \$H\$

Users who discover the PROMPT command's flexibility invariably end up creating strange prompts such as

PROMPT + \$Q\$Q\$Q\$Q\$Q = \$ _ \$B \$H \$G \$B \$ _ + \$Q\$Q\$Q\$Q\$Q = \$ _
which produces

```

+=====+
|  C>  |
+=====+

```

or perhaps

PROMPT SL\$N\$C SL\$N\$C\$ SB\$ SQ\$Q\$Q\$

which yields

<C> <C>

↓

A less frivolous use of the PROMPT command is in sending Escape sequences to the ANSI.SYS extended screen driver, which can give you precise control over the way your monitor looks and works. See PC Lab Notes, Volume 6 Number 5.

The real strength of including SP in any PROMPT command is that when you log into a subdirectory, DOS will display the name of that subdirectory. So if your PATH setting is SP, and you create a subdirectory called STAR where you keep all your *WordStar* files, and you move from the root directory into that subdirectory, your prompt will change from

C:\

to your exact location in

C:\STAR:

To see the command that most recently configured your prompt, type SET on a line by itself, which displays the system's "environment"—the fundamental settings that tell DOS where to look for key files and how to prompt the user. To restore the prompt to its original C>, just type PROMPT with nothing following it.

Customizing your prompt isn't all roses. Once you tell DOS to include the subsidiary name in the prompt, it will relentlessly seek one out. So if you have a SP in your PROMPT command and log into a floppy drive, then remove the disk from that floppy drive and do something that generates an "Abort, Retry, Ignore?" (or "Abort, Retry, Fail?") in DOS 3.3) message, DOS won't budge until you stick the diskette back in the floppy slot.

A second disadvantage is that if you have tons of multilayered subdirectories with long directory names, and you're

BOOTING UP WITH BERNIE

Everyone knows the first thing DOS does after turning itself on is look for a batch file called AUTOEXEC.BAT and try to run it if it's there, right?

Not if it's busy booting BERNIE.

The mechanism that tries to sniff out the existence of a bootup file is buried in COMMAND.COM. This bootup file doesn't have to be called AUTOEXEC.BAT. In fact, it doesn't even have to end in .BAT.

It's easy to change the name of this bootup file to something innocuous like BERNIE. This will prevent others from using the TYPE command to look inside AUTOEXEC.BAT to see what files you use when you start your system. And it will keep all those snoops at bay by displaying a special message designed to confuse. Here's how to do it:

First, make sure you have copies of COMMAND.COM and AUTOEXEC.BAT stashed safely away, since the process described below alters COMMAND.COM slightly. If you try this and want to put things the way they were, all you'll have to do later is copy your old original COMMAND.COM over the patched one, and then copy it and the original AUTOEXEC.BAT back to the root directory.

Put DEBUG.COM and a copy of COMMAND.COM in your root directory. If you've never used DEBUG.COM before, it's on your Supplemental DOS disk, not the main one. Stupidly, IBM removed DEBUG.COM from DOS Version 3.3.

This process assumes that you normally boot from a system with a C: hard drive, and that you have a subdirectory called C:\DOS. If not, it's pretty simple to figure out how to adapt it.

To get the ball rolling, enter
DEBUG COMMAND.COM

You should see a hyphen at the left edge of your screen. This is the DEBUG prompt. Type

S 100 5000 "AUTO"

and DEBUG should print two pairs of four-digit hexadecimal numbers (hex numbers can be made up of the numerals 0-9 plus the letters A-F), separated by a colon. Ignore the leftmost four digits; they'll vary from system to system and they don't matter here. But note the rightmost four digits; this is where the name \AUTOEXEC.BAT is located inside COMMAND.COM. Now enter

E **** "DOS\BERNIE "

but substitute those rightmost four digits in place of the ****. For instance, if DEBUG responded earlier with

54BA:130F

after you entered the line beginning with the S, you would enter E 130F "DOS\BERNIE_" there.

Note that you must include two blank spaces between BERNIE and the rightmost quote mark. This is because \DOS\BERNIE is two characters shorter than the \AUTOEXEC.BAT that appears inside COMMAND.COM. You have to pad over all existing letters in AUTOEXEC.BAT with spaces if your new name isn't as long.

Then type W, hit the Enter key, type Q, and hit the Enter key.

Finally, copy your AUTOEXEC.BAT routine to your \DOS subdirectory and name it BERNIE, and then delete it from the root directory, with the commands

COPY AUTOEXEC.BAT
DOS\BERNIE
DEL \AUTOEXEC.BAT

You can then create a phony AUTOEXEC.BAT file in your root directory that contains the line

PROMPT Access Denied\$

If another user tries to run AUTOEXEC.BAT, all he'll get is a screenful of

Access Denied

prompts. You can even adapt the above technique to patch COMMAND.COM so that it changes the DIR command most snoops will try to use to see what's on your disk.

Enter

DEBUG COMMAND.COM

and then

S 100 5000 "DIR= 3

(including the 3 is important, since the letters DIR appear in COMMAND.COM several times, but you're looking for the only one that is followed immediately by a 3). DEBUG will print another two pairs of hex numbers that are separated by a colon. Then enter

E **** "DUR=

but again, substitute the four rightmost hex digits for the ****. Then type W and hit the Enter key, then type Q and hit the Enter key, and then reboot. If you type in DIR you'll get a "Bad command or filename" error. If you type in DUR you'll see your normal directory listing. Remind others using your system that you've changed the DIR command.

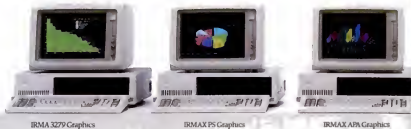
A word of caution, though—don't mix versions of COMMAND.COM. DOS checks to make sure the version it dealt with originally is not different from one you're trying to use later. That's why you made copies of your originals before you started.—Paul Somerson

logged into one five levels deep, the prompt may be so long that your commands may wrap around the right edge of your screen. Contributing editor Stephen Manes has the best solution—keep subdi-

rectory names short. While subdirectories are really just specially treated files, and can have 11-character names just like files, avoid the temptation. In addition to preventing wraparound problems, this will

make it far easier to switch between subdirectories. It's a lot simpler to type \WS\UT than \WORDSTAR\UTILITY\WPR, especially when you're doing it several times a day. (While you're at it,

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■ Your system will run without a CONFIG.SYS file, but it will work better with one than without.

truncate the names of programs you use every day. Why type EDITOR when you could just key in ED?) Also, resist the temptation to use extensions in subdirectory names since they'll just make the whole process more cumbersome and prone to error. Another solution to wrap-around ills, by the way, is to end all your prompts with a \$... which jumps the cursor down to column 1 of the line below.

CLEANING UP YOUR ACT The only other file that has to be in the root directory is CONFIG.SYS. Your system will run without a CONFIG.SYS file, but it will work better with one than without. And certain programs demand one. If you're using a database manager, for instance, that handles more than eight open files at once, you have to prepare DOS for juggling the extra ones with a FILES= command in CONFIG.SYS. You can also do things like use the COUNTRY= command to mix and match foreign currency symbols and odd time and date formats.

But where CONFIG.SYS really shines is in increasing disk-read buffers, loading device drivers, and adding logical drives to your system.

For some odd reason, IBM specified a default of two buffers for the XT, and a paltry three for the AT. Buffers are simply chunks of memory set aside to store the data your system most recently read from or wrote to your disk. If you have to go back and read the same data, it's far speedier to do so via these memory buffers than to have to move the magnetic heads again and slurp up the information from the physical disks one more time.

Buffer needs vary from system to system, and the number of buffers is often a

topic of heated discussion when tech types get together. Virtually everyone agrees that three is a joke. Somewhere around 10 or 15 seems right for XT users, and 20 or 30 for AT users. Specifying too many is as detrimental to performance as too few, since your system will end up wasting time "thrashing the heads" as it churns through data it will never use. DOS 3.3 adjusts this automatically.

If you currently have a directory crammed with hundreds of files, it's easy to demonstrate how increasing the number of buffers can help boost performance. First, make sure you don't have a CONFIG.SYS file, or that if you do it doesn't contain a BUFFERS= command. If yours does, rename it temporarily.

Reboot and issue a DIR command. The first few dozen files scroll rapidly by, but eventually the buffers fill and the display suddenly turns balky. If you get tired of watching your files bounce slowly upward, interrupt the directory listing by holding down the Ctrl key and tapping either the C key or the ScrollLock key. Then, when you're back in the root directory at the DOS prompt, create a CONFIG.SYS file by typing

```
COPY CON CONFIG.SYS
```

and then hitting the Enter key. The cursor will drop down a line. Type

```
BUFFERS=15
```

and then hit Enter, the F6 function key, and then the Enter key again. You'll see the message

```
1 File(s) copied
```

Reboot and reissue the DIR command. Now virtually all the files will fly by, not just the first few, since your system can load a giant chunk of directory data from your disk into memory at one pass and not have to keep reading the disk in little sips.

CONFIG.SYS is also where you instruct your system to load device drivers such as the DOS VDISK.SYS "virtual disk" (RAMdisk), or drivers to link your basic hardware with mice, nonstandard external storage devices, pre-DOS 3.3 3½-inch floppy drives, or giant hard disks.

And it's where you tell DOS how many drives you're going to want to use. When you boot up, DOS assumes a maximum of

five (drives A: through E:). But if your system is loaded to the gills with hard disks, half-heights, microfloppies, and other exotica, you might need more. And if you use the SUBST command to fool your system into treating a subdirectory like a disk drive to get around PATH or environment limitations, you'll have to prearrange it with a "LASTDRIVE=" CONFIG.SYS command.

Apart from the hidden DOS system files, COMMAND.COM, AUTOEXEC.BAT, and CONFIG.SYS, a well-organized disk's root directory should contain no other files. Well, technically, if you used the /V switch in formatting your hard disk or later added a volume label with the LABEL command, the name itself is kept in an additional hidden file.

Some users don't mind having their important DOS utilities in their root directory, and cut through the clutter of a messy directory with a DIR/P (paused directory) or DIR/W (wide directory) command. This won't radically degrade performance, and may actually be a hair faster than storing them in a separate \DOS subdirectory, if these files are kept at the very beginning of the hard disk directory. But it's even faster to keep them on a RAMdisk. And clutter gets to be a bad habit—soon you start dumping files anywhere. Users who run Michael J. Mefford's (REPEATS.COM) duplicate-file finder in this issue (Programming/Utilities) are always amazed at the large number of misplaced and misfiled programs and data.

Earlier we said it was a good idea to clean up a root directory that was cluttered with extraneous files. If all a dealer or corporate systems installer did when setting up your brand new system was copy all the DOS files from their original floppies to your root directory, you can go ahead and erase everything except COMMAND.COM (which you'll need to reboot).

You can see if all the files in your root directory are also on your DOS disk by putting the DOS disk in drive A: and then typing

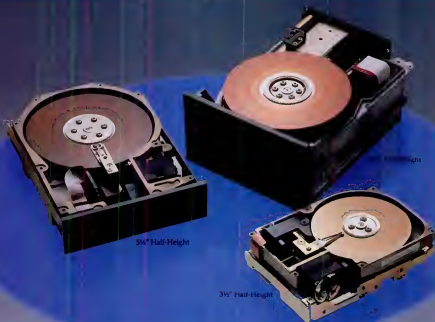
```
DIR C: /W
```

and then

```
DIR A: /W
```

for a wide-display, filenames-only listing.

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Or, turn on your printer and either type

```
DIR C: > PRN
```

and then

```
DIR A: > PRN
```

or hold down the Ctrl key and hit P (or PrtSc) to toggle your printer on so that it echoes everything simultaneously to the printer and the screen and type DIR C: and then DIR A: for a printed copy of your directory listing. If you used the Ctrl-P (or Ctrl-PrtSc) technique to turn simultaneous printing on, hold down the Ctrl key and type P (or PrtSc) once more to toggle it off.

You can also see what's on your disk by sorting the files in order of their extension. The command

```
DIR | SORT /+10 | MORE
```

will make it easy. For this to work, the DOS SORT.EXE and MORE.COM files must be on the current directory or in directories that you've included in your PATH command.

Any way you do it, if you see that all you have on your root directory is DOS files, erase all but COMMAND.COM (you'll put them back in their proper place later).

If you have AUTOEXEC.BAT or CONFIG.SYS files, examine their contents by using the TYPE command. To see what's inside CONFIG.SYS, just type

```
TYPE CONFIG.SYS
```

If you see other files listed, such as

```
DEVICE=VDISK.SYS 360
```

```
DEVICE=ANSI.SYS
```

```
DEVICE=MOUSE.SYS
```

you'll want to leave VDISK.SYS, ANSI.SYS, and MOUSE.SYS where they are on the root directory. Later you can move them out of the root directory to a subdirectory called \BIN (so named because that's where you store your programs, which are in binary, nontext format), and change the CONFIG.SYS file so that it says

```
DEVICE=\BIN\VDISK.SYS 360
```

```
DEVICE=\BIN\ANSI.SYS
```

```
DEVICE=\BIN\MOUSE.SYS
```

Similarly, if you use the TYPE command to examine AUTOEXEC.BAT and see that it loads SideKick with the com-

mand SK, leave SK.COM in the root directory for now. Later, if you create a third-level subdirectory below \BIN called \BIN\KICK and move your SideKick files there, you would change the line in your AUTOEXEC.BAT file from

```
SK
to
\BIN\KICK\SK
```

CHOCK FULL You can store up to 64 files in the root directory of a single-sided floppy disk (if you can still find one), and 112 files in the root directory of a more common 360K floppy. The root directory of larger diskettes holds 224. And there's space on most hard disk root directories to store 512 files.

But don't test this out on your hard disk. If you do, you'll end up after the 509th with a "File creation error" message (the 510th, 511th, and 512th are the two hidden system files and the hidden volume label). Any subdirectory entries you may have in the root directory are really just special types of files, so they're included in the count too. So you run out of room well before you actually have a chance to create file 512.

The number of directory entries in a subdirectory is limited only by available space on the disk. That's because each subdirectory is really just a special kind of file that keeps track of other files. Because the subdirectory itself is a file, it can grow the same way a data file grows when you add information to it.

Remember—if you really want to organize your hard disk properly, don't put any other files on your root directory besides the ones mentioned above. Then, when you type

```
DIR C:\
```

all you'll see is one screenful of your boot-up files and main subdirectory listings. It'll be an index into your well-organized hard disk.

DISK TOOLS When IBM introduced its hard disk XT, it added several Unix-like subdirectory features (as well as a Unix-like tree structure) to the new release of DOS that accompanied it (Version 3.3

adds an APPEND command to enhance PATH searches for nonexecutable files). Among these powerful new commands were

```
MKDIR (and MD)
RMDIR (and RD)
CHDIR (and CD)
PATH
```

Nobody anywhere ever uses MKDIR, RMDIR, and CHDIR, since the shorthand versions MD, RD, and CD will do just fine. Avoid them, unless you're the kind of prolix twit who prefers words like "utilize" rather than the shorter "use." Of course, since the IBM DOS manual is not exactly what you'd call friendly, you can't look up these commands by hunting for the shorthand versions in the alphabetical reference section. MD, CR, and RD aren't even in the DOS manual's index. Nice touch, IBM.

The MD command creates a new subdirectory. The first thing you should do after running FDISK and FORMAT is create a DOS subdirectory. To do this, type

```
MD \DOS
```

If you were sure you were in the root directory, you could also type

```
MD DOS
```

since both commands will do the same thing—create a subdirectory one level down from where you currently are, in the root directory.

By omitting the Backslash (as in MD DOS) you're saying, "Create a directory called DOS that's one level down in the subdirectory tree from where I currently am." By including the Backslash (as in MD \DOS) you're saying, "Create a directory called DOS that is one level down from the root directory," since the single Backslash specifies the root directory.

The method *without* the Backslash uses **Relative** locations. The technique *with* the Backslash uses **Absolute** locations. Both have their advantages. We'll discuss this in more detail later. This is a critical distinction and a point of real confusion among new hard disk users. (And it isn't all that unusual; many DOS commands allow alternate phrasings. For instance, you can use several different syntaxes to perform the same COPY command, depend-

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ing on what you want to do.)

Once you've created the \DOS subdirectory, log into it (or Change Directories) from the root directory by issuing the CD DOS (or CD \DOS) command. Here's a shortcut—once you've typed MD \DOS to create the subdirectory, type the letter C and then hit F3. F3 repeats the previous command, so it will fill in the command line with the rest of what you typed at the previous DOS prompt. So at the C> prompt, you'd type

```
MD \DOS
```

and hit the Enter key. Then you'd type

```
C
```

and hit F3. As soon as you did you'd see

```
C>CD \DOS
```

Hit the Enter key and DOS will log you into your new \DOS subdirectory, and you'll see

```
C>
```

How do you know you're in the \DOS subdirectory? If you type in DIR you'll get something like

```
Volume in drive C is PC MAGAZINE
Directory of C:\DOS

<DIR>        6-18-87  18:48p
<DIR>        6-18-87  18:48p
  2 File(s)  28848448 bytes free
```

You can see the current directory in the second line of the DIR report. But if you remembered to set your PROMPT to \$P: you could automatically tell which directory you were logged into, since instead of

```
C>
```

as soon as you typed CD \DOS you'd see

```
C:\DOS:
```

Typing CD by itself will also display the current subdirectory. But that's an extra step.

Notice that DOS already thinks you have two files in the \DOS subdirectory with the peculiar names * and .. and with <DIR> where the file size usually goes. We'll talk about the dot notation a little later. The <DIR> tells us we're dealing with subdirectory entries.

Now go back to the root directory. You can do this one of two ways.

You can use the absolute location technique and issue a command that says "move to the root directory"

```
CD \
```

or you can say "move one level up from where I am" with the command

```
CD ..
```

You could have typed CD\ rather than CD \ and CD.. rather than CD .., since in this case DOS isn't picky about extra spaces. The double dot stands for the "parent" directory of the one you're currently logged into—the directory (or subdirectory) directly one level up toward the root. In this case, the only level up is the root.

If you're curious, the single dot stands for the directory you're currently in. This shorthand actually comes in handy when you're prompted for a subdirectory name and you're in one that's five levels deep and would rather type a single period than a long, elaborate pathname—although just pounding on the Enter key sometimes works in such situations.

In any event, once you've used the CD\ or the CD.. command and you're back in the root directory, type DIR and you'll see a new listing along with

```
Volume in drive C is PC MAGAZINE
Directory of C:\

COMMAND.COM  23218  3-87-85  1:43p
CONFIG.SYS   128    1-11-87  3:27p
AUTOEXEC.BAT 648    2-22-87  8:12p
DOS           <DIR>   6-18-87  18:48p
```

The <DIR> tells you that you now have a subdirectory one level down from the root directory.

IMPORTANT FILES You should now copy all the important files from your DOS floppy disks into your new DOS subdirectory. You can log onto drive A: and type

```
COPY *.* C:\DOS
```

or, while working in the root directory in drive C:, type

```
COPY A:*.* \DOS
```

Or you could log into C:\DOS (with the CD DOS or CD \DOS command) and type

```
COPY A:*.*
```

Make sure you copy the important files from both the main DOS floppy disk and

the supplemental one. However, you can skip some of the files nobody ever uses, such as VDISK.LST (a long assembly language source code file for programmers), anything ending with a .BAS extension (unless you think DONKEY is an exciting and challenging game), and some of the stranger utilities such as KEYBIT.COM and KEYBFR.COM, which load in foreign keyboard templates (in this case Italian and French). You can also toss BASIC, since BASIC does everything BASIC does and more. It's hard to believe, but some of the programs on even the most recent version of DOS will work only on the PCjr; try running MUSICA.BAS, for instance. Do, however, copy DEBUG.COM, which, for some bizarre reason, is on the Supplemental DOS disk. DOS 3.3 does away with frivolous files. However, it also does away with DEBUG.

Now that you've created a subdirectory (called \DOS) one level down from the root directory, go ahead and create another subdirectory on the same level as \DOS, called \BIN. But be careful. Why?

If you're currently logged into either the root directory or the \DOS directory, you could create \BIN with the ABSOLUTE command

```
MD \BIN
```

This command, in effect, says, "Create a subdirectory one level down from the root directory and call it BIN." The single \ prefix means "one level down from the root directory." However, if you forget the Backslash and try the command

```
MD BIN
```

two things will happen, depending on where you currently are on your hard disk, since omitting the Backslash makes this a Relative command rather than an Absolute one. Typing MD BIN will create a subdirectory one level down from where you currently are. So if you're currently logged into the root directory, MD BIN will create a subdirectory called \BIN that's one level down from the root.

But if you're currently logged into \DOS, which is already one level down from the root, and you type MD BIN, you'll end up creating a subdirectory called \DOS\BIN that's one level down from \DOS and two levels down from the



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had better be sure
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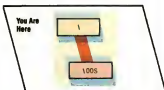
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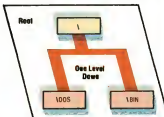
■ HARD DISK ORGANIZATION

root. That's because leaving out the Backslash command makes it a **Relative** command rather than an **Absolute** one.

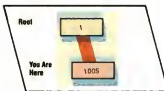
To recap, if you already have a subdirectory called \DOS, but you're currently logged into the root directory



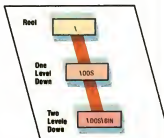
and you type MD BIN, you'll end up with



which is what you want. But if you're already one level down, in \DOS



and you type MD BIN, you'll get



Actually, it really doesn't matter which way you set up your subdirectories. Most

users aren't really comfortable creating tree structures any more complex than one or two levels deep. Others prefer intricately filigreed systems. For best results, Keep It Simple. The only real reason to create lots of subdirectories branching off of each other is if your work demands it.

For instance, if you're a CPA with many clients, each one deserves its own subdirectory, and each will require still deeper subdirectory levels of organization. It's good practice to keep records separated by year or quarter or even month (depending on the quantity of files). But while it might make sense to keep expenses in one subdirectory and income in another, it would be ridiculous to have one called

```
\SMITHCO\1987\JUNE\EXPENSES\OFFICE\PENCILS
```

and another

```
\SMITHCO\1987\JUNE\EXPENSES\OFFICE\STAPLES
```

NECESSARY UTILITIES If you've followed the above instructions properly, you now have two subdirectories called \DOS and \BIN, each a single level down from the root directory. \DOS contains all the important files you copied from your two main DOS disks. \BIN should contain all the smaller non-DOS utilities and batch files you use every day.

Two utilities you absolutely, positively should have on your hard disk are VTREE.COM and BROWSE.COM, both written by contributing editor Charles Petzold for *PC Magazine's* Programming/Utilities column (Volume 4 Number 22 and Volume 5 Number 6). They're both on Volume I of the PC Magazine Utilities disk, which is given away free to new and renewing subscribers. (You could download them at no charge from the PC Magazine Interactive Reader Service bulletin board, (212) 696-0360, 1,200 bps, no parity, 8 data bits, 1 stop bit. Or create VTREE.COM by typing in and running the BASIC program in Figure 2.) And both belong in the \BIN subdirectory.

VTREE.COM displays a pictorial representation of the tree structure of the subdirectories on your hard disk. BROWSE.COM is a replacement for the DOS TYPE command that lets you scan rapidly through your files. Vernon Buerg's LIST

.COM (available from his bulletin board at (415) 994-2944) is an even fancier version of BROWSE.

Once you've created your \BIN subdirectory, copy VTREE.COM and also copy BROWSE.COM into it (by adapting any of the syntaxes you used to copy your DOS files into \DOS, above). Log into \BIN by typing

```
CD \BIN
```

and run VTREE by typing

```
VTREE
```

You should see something that looks like this:

```
--+-- DOS
|
|--+-- BIN
```

This may not be a very impressive graphical representation, but it's vastly better than the disgraceful, nearly useless output produced by the DOS TREE.COM utility. All TREE.COM does is grind out a long, slightly confusing textual description. With just 2 subdirectories it's not so terrible, but with 20 or 30 all you get is an unmanageable scrolling mess. And displaying a graphic object such as a hierarchical tree with words alone is like trying to describe colors to someone who's congenitally blind.

TREE's version of the above subdirectory structure is

DIRECTORY PATH LISTING FOR VOLUME PC MAGAZINE

```
Path: \DOS
Sub-directories: None
```

```
Path: \BIN
Sub-directories: None
```

You can make TREE slightly more useful adding a /F switch, which will display all the files in all the subdirectories. But even this use of TREE is overshadowed by the far better CHKDSK /V, which also lists all the files on your disk. CHKDSK/V displays full path names; TREE /F doesn't. And TREE pads all its listings with unnecessary spaces, which makes it scroll rapidly off your screen. As a bonus, CHKDSK /V adds the standard CHKDSK report detailing the number of files, bytes free, etc. And it displays the hidden files; TREE /F


```

100 ' Program for creating VTREE.COM -- by Charlie Petzold
110 CLS:PRINT "Checking DATA; please wait..."
120 FOR B=1 TO 32:FOR C=1 TO 16:READ AS:TTL=VAL("&B"&A$):NEXT
130 READ B:IF B=TTL THEN 150
140 PRINT "DATA ERROR IN LINE"&B*16+190: -- REDO:END
150 TTL=0:NEXT:RESTORE
160 OPEN "VTREE.COM" AS #1 LEN=1:FIELD #1,1 AS D$
170 FOR B=1 TO 32:FOR C=1 TO 16:READ AS
180 LSET D$=CHR$(VAL("&B"&A$)):PUT #1:NEXT:READ DUMMYS:NEXT
190 CLOSE:PRINT "VTREE.COM CREATED"
200 DATA EB,5F,98,08,3A,5C,2A,2E,2A,08,28,43,29,28,43,6F,1112
210 DATA 78,79,72,69,67,68,74,28,43,68,61,72,6C,65,73,28,1545
220 DATA 58,65,74,7A,6F,6C,64,2C,28,31,39,38,35,49,6E,76,1338
230 DATA 61,6C,69,64,28,64,69,73,6B,28,64,72,69,76,65,24,1475
240 DATA 52,65,71,75,69,72,65,73,28,44,4F,53,28,32,28,38,1286
250 DATA 28,2B,24,08,08,08,5C,2A,2E,2A,08,06,03,3C,03,08,483
260 DATA 08,3C,FF,75,0A,8D,16,2D,01,84,09,CD,21,CD,28,04,1495
270 DATA 38,CD,21,3C,02,73,06,8D,16,40,01,EB,EC,A8,5C,08,1428
280 DATA 0A,0C,75,06,04,19,CD,21,FE,C8,0A,08,40,40,A2,03,1793
290 DATA 01,FC,08,16,5D,01,84,1A,CD,21,8B,1E,54,01,03,0B,1428
300 DATA 08,3E,53,01,08,75,12,C7,07,FC,02,08,08,0A,03,01,1107
310 DATA B9,18,08,04,0E,CD,21,EB,04,84,4F,CD,21,73,03,09,1784
320 DATA DE,08,36,5D,01,88,7C,15,18,75,ED,03,C6,1E,08,1639
330 DATA 3C,2E,74,05,FF,07,FC,02,08,0E,54,01,EB,3A,03,0F,1948
340 DATA FC,02,01,74,21,2B,0B,08,03,77,07,FC,02,08,08,74,1981
350 DATA E2,0B,28,EB,FD,08,01,59,18,08,08,28,EB,F4,08,E2,1887
360 DATA F9,59,43,43,E2,01,83,BF,FC,02,01,75,08,08,0E,5F,1876
370 DATA 01,0A,C4,EB,DD,08,E2,F9,56,08,36,5D,01,BF,08,08,1993
380 DATA 0B,07,09,2B,08,FC,A4,5E,04,1A,CD,21,B4,4F,CD,21,2824
390 DATA 72,14,08,3E,95,08,18,75,73,08,C2,03,BF,FC,02,01,1796
400 DATA 74,15,08,C3,EB,11,08,C4,03,BF,FC,02,01,74,08,2809
410 DATA C8,01,6F,FC,02,08,08,EB,59,08,08,C4,EB,94,08,08,2159
420 DATA 28,EB,6F,08,08,08,08,08,3E,5B,01,AC,0A,C8,74,06,1394
430 DATA AA,08,77,08,E2,05,08,28,EB,08,08,08,08,5F,01,09,1944
440 DATA 3E,5B,01,FF,06,5B,01,BE,56,01,B9,05,08,F3,A4,FF,1636
450 DATA 06,54,01,C6,06,53,01,08,03,06,5D,01,2B,E9,F2,FE,1382
460 DATA 03,3E,54,01,08,74,A4,F7,07,FC,02,FF,7F,75,0A,B8,1789
470 DATA 0D,EB,3F,08,0A,EB,3A,08,08,BF,03,01,B9,46,08,B8,1410
480 DATA 08,F2,AE,4F,B9,48,08,08,5C,FD,F2,AE,F2,AE,47,89,2385
490 DATA 3E,5B,01,FF,06,5B,01,BE,56,01,B9,05,08,FC,F3,A4,1633
500 DATA FF,0E,54,01,C6,06,53,01,08,03,2E,5D,01,2B,E9,A1,1633
510 DATA FE,CD,28,52,6A,08,B4,02,CD,21,5A,C3,08,08,08,08,1624

```

Figure 2: Contributing editor Charles Petzold's program to create VTREE.COM utility, which produces a graphic representation of a hard disk's hierarchical tree structure.

doesn't. Finally, CHKDSK /V is far faster. Chugging through slightly more than 2,000 files on an AT took CHKDSK /V 98 seconds. TREE /F produced an inferior report and took 123 seconds, or 25 percent longer.

When you copy VTREE.COM into your \BIN directory, the very next thing you should do is type

```
ERASE \DOS\VTREE.COM
```

DUPLICATE NAMES Note that in the above example, the full name of the primitive DOS utility that you just expunged was \DOS\VTREE.COM rather than just TREE.COM. That's because you can have different versions of similarly named

files in different subdirectories. You can even have similarly named subdirectories; if you wanted to (and you don't) you could have a subdirectory called \DOS and one called \BIN\DOS on the same disk.

For instance, you could rename Petzold's VTREE.COM to TREE.COM and put it in \BIN. So if you kept the original DOS version in the \DOS subdirectory, your hard disk would then contain files called

```
\DOS\VTREE.COM
```

(which is the original DOS version) and

```
\BIN\TREE.COM
```

(which is the renamed version of the VTREE.COM utility). To run the original

DOS tree version, you'd need to type

```
\DOS\TREE
```

To run Petzold's VTREE.COM, which for this example you renamed to TREE.COM, you'd type

```
\BIN\TREE
```

If you were in the root directory and hadn't yet used the PATH command to tell DOS where to look for executable files and you typed

```
TREE
```

you wouldn't run either \DOS\TREE or \BIN\TREE; all you'd get is a "Bad command or file name" message. As discussed above, when you type in a command like TREE at the DOS prompt, COMMAND.COM first checks whether it's an internal command, and if it discovers it's not, checks a specified set of directories (called a PATH) for a file by that name with a .COM, .EXE, or .BAT extension. If \DOS and \BIN aren't yet included in the path, COMMAND.COM won't check in those subdirectories, and won't run either version of TREE.COM.

You can tell COMMAND.COM to check in both of these subdirectories with the command

```
PATH C:\DOS;C:\BIN
```

or

```
PATH C:\BIN;C:\DOS
```

The difference between these two is that if the top path is active, DOS will look in the \DOS subdirectory before it looks in \BIN. In the second example it will examine \BIN before \DOS. If DOS finds a TREE file ending in .COM, .EXE, or .BAT, it will stop looking and execute the file. If the first path is in use, typing TREE will run the DOS version of TREE. If the second path is in use, DOS will find Petzold's renamed version of VTREE.COM and then run it.

Incidentally, if you had files called TREE.COM, TREE.EXE, and TREE.BAT in either subdirectory, DOS would run TREE.COM. It always looks for .COM files first, then .EXEs, and finally .BATs. But DOS 3.2 or earlier won't look for filenames with any other extensions, such as data files or program overlays.

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■ Keeping subdirectory names short saves environment space and wear and tear on your typing fingers.

This is a genuine problem that most power users get around by buying "path extenders" that will look for any file with any extension in any specified subdirectories. The two most popular are SDA Associates' wonderful *FilePath* and a program called *File Facility*, written by an IBM employee and marketed half-heartedly by IBM. DOS 3.3 solves the problem with APPEND. They both work about the same.

It's best to include a path command like either of the ones above in your startup AUTOEXEC.BAT file. And if you're using a path extender or APPEND, add a separate line for it too.

We mentioned earlier that you could type SET to see the command that most recently configured your prompt. Typing SET on a line by itself will also display the current path setting. Typing PATH by itself will also do so. Modify your existing path setting by following the PATH command with the new list of subdirectories, joined together with semicolons.

A smarter technique for adding path settings, suggested by DOS expert Marvin Avery and adapted here, is to exploit the trick of using environment settings as variables.

Create a small batch file called ADDPATH.BAT by getting into DOS, typing in the lines below, hitting the Enter key at the end of each one, and then hitting the F6 key and the Enter key one final time when you're all done. Do it right and you'll get a "I File(s) copied" message afterwards:

```
COPY CON ADDPATH.BAT
IF %1(==GOTO END
PATH=%PATH%;%1
:END
```

To test it out, assuming you don't already have any path set, create a simple path to your C:\DOS directory with

```
PATH=C:\DOS
```

Then type either PATH or SET to make sure you typed it in properly. To extend the path so it included C:\BIN, you'd ordinarily have to type

```
PATH=C:\DOS;C:\BIN
```

But if you have ADDPATH.BAT handy, all you have to do is type

```
ADDPATH C:\BIN
```

Then type SET or PATH again and you'll see the path setting has indeed been extended.

This isn't such a typing saver with such a small path. But when your path goes all the way across the screen, you'll appreciate it. It works by using an environment setting as a variable (the %PATH% is a variable that tells DOS, "Look inside the current environment setting and substitute, in place of the %PATH% in the batch file, whatever follows the word PATH="). The technique also uses what is called a replaceable parameter—the %1. When DOS sees this in a batch file, it replaces the %1 with the first word or string of characters you typed on the command line immediately following the name of the batch file.

So if the batch file is called ADDPATH and at the DOS prompt you typed

```
ADDPATH HELLO THERE
```

it would replace the %1 with HELLO. If you wanted it to replace %1 with "HELLO THERE", you'd have to type either

```
ADDPATH HELLO THERE
```

or, alternatively,

```
ADDPATH HELLO..THERE
```

since the %1 stops when it sees a space (or other "delimiter" DOS uses to separate words).

The "IF %1(==GOTO END" (note the double equal sign) tests to see whether you typed anything in after the name of the batch file. If you did type something in, like HELLO, DOS replaces the %1 with HELLO and turns the test into

```
IF HELLO(==GOTO END
```

Now, HELLO(is clearly not equal to (, so the test fails.

However, if you entered nothing after the name of the batch file, %1 would be equal to nothing, and DOS would turn the test into

```
IF (==(GOTO END
```

Sure enough, (does equal (, so the batch file will jump to the "label" called :END. (Labels are preceded with colons and don't execute.) What this effectively does is jump around the "PATH=%PATH%;%1" command if you forgot to enter an additional path extension.

However, if you did enter a new subdirectory and you wanted to have it tacked onto the end of your path, DOS would "concatenate" it when it came to the line "PATH=%PATH%;%1". It would replace the %PATH% with the current path and the %1 with the new subdirectory you just typed in. And it would tack on the semicolon DOS uses to separate subdirectories. If the current path was

```
PATH=C:\DOS
```

and you typed in

```
ADDPATH C:\BIN
```

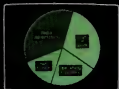
you'd end up with

```
PATH=C:\DOS;C:\BIN
```

If your PATH gets extremely long, you can quickly run out of space. You're limited to a default environment space (the place DOS stores its PATH and PROMPT information) of 160 bytes. PC Lab Notes in Volume 6 Number 7 explains how to get around this limitation with the little-used SHELL command in your CONFIG.SYS file. If you try this, remember that the SHELL command in DOS 3.0 and 3.1 is undocumented and works by specifying extra space in 16-byte chunks called paragraphs; in Version 3.2 it's documented but specifies the actual number of bytes, not paragraphs. If you currently use Version 2.1, get with it and upgrade. This trick and new commands like XCOPY and APPEND are worth the modest cost.

Keeping subdirectory names short saves environment space and wear and tear on your typing fingers. It's also a good idea because the CD command can't handle more than 64 characters. If you also-

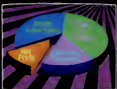
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■ HARD DISK ORGANIZATION

lutely can't live without long subdirectory names, and you run out of environment space, you can always use the SUBST command as shorthand in your AUTOEXEC.BAT file. Subdirectories really work pretty much like individual disk drives. SUBST blurs the distinction.

If you have a tangle of subdirectories on your hard disk like

```
C:\ABLE\BAKER\CHARLIE\FOXTROT
```

you could issue the SUBST command

```
SUBST E: C:\ABLE\BAKER\CHARLIE\FOXTROT
```

before you issue the PATH command. Then the short path command

PATH E:

will tell DOS to include the subdirectory C:\ABLE\BAKER\CHARLIE\FOXTROT in its path searches. This method cuts down on your typing and lets you treat long subdirectories the exact same way you'd treat drives. If you type

DIR E:

you'll see what files are included in C:\ABLE\BAKER\CHARLIE\FOXTROT. You can also use this trick to copy files in and out of that subdirectory. And you can log into it just by typing E: at the prompt. Note that you can't use a higher drive letter than E: unless you want DOS beforehand in your CONFIG.SYS file with the LASTDRIVE= command. And you can create such drives temporarily.

```
SUBST E: /D
```

will undo the substitution. But if you're going to use this trick, read all the warnings in the SUBST section of the DOS manual. Commands like LABEL and BACKUP can cause problems with it. And SUBST is magic with programs like *WordStar 3.x* that can find their overlays on specified drives but not subdirectories (APPEND is even better).

Notice that each of the subdirectories is preceded by a drive letter, C:. If all you ever do is use your C: hard disk and never log onto a RAMdisk or a floppy, you can omit this. A path such as

```
PATH=\DOS;\BIN
```

would work just as well in that case.

However, you should include the drive letters, because if you really want to boost performance you'll create a RAMdisk and copy your most frequently used programs—and all your long complex batch files—into it.

SPEEDY DEVICES As every power user knows, a RAMdisk is a section of memory that some software has tricked DOS into treating like an additional physical disk drive. RAMdisks are far faster than even the fastest hard disks, since they contain no moving parts. The tradeoff, of course, is that RAMdisks are volatile; all data stored on them vanishes when you turn the power off or when the current in your wall socket hiccups.

■ **RAMdisks are volatile;**
all data stored
on them vanishes when
you turn the power off.

To install the free RAMdisk that comes with later versions of DOS, make sure the DOS VDISK.SYS program is in your C:\DOS subdirectory and include a line in your CONFIG.SYS file that says

```
DEVICE=C:\DOS\VDISK.SYS
```

This command will set up a virtual drive D: with 64K of available space. If you want a larger RAMdisk, you can specify the number of bytes at the end of the command.

```
DEVICE=C:\DOS\VDISK.SYS 360
```

would set up a drive D: that's the same size as a standard double-sided floppy. However, IBM won't let you DISKCOPY into it. RAMdisk software from other manufacturers, such as AST's SUPERDRV, will let you use the DISKCOPY command. IBM's VDISK driver will let you create multiple virtual disks, configure the sector size and number of directory entries, and, in the most recent versions of DOS, use extended memory.

The trick is to figure out which major programs, batch files, and utilities you use frequently and insert a cascade of commands in your AUTOEXEC.BAT file to copy those files to the RAMdisk. Then make sure your path includes this new drive. In the example we've been using, the path would now look like

```
PATH=D:\;C:\DOS;C:\BIN
```

Putting D:\ first means that the root directory of the RAMdisk is the first place DOS will look.

It's smart to put all your batch files except the tiniest ones into a RAMdisk, since batch files execute one slow line at a time. Watching even a hard disk grind its way through a medium-sized batch file is no fun at all.

Let's say you use three programs very often: CHKDSK.COM, a color-setting and screen-clearing program called C.COM, and BROWSE.COM. Your AUTOEXEC.BAT file would contain the lines

```
COPY C:\CHKDSK.COM D: > NUL  
COPY C:\C.COM D: > NUL  
COPY C:\BROWSE.COM D: & COM > NUL
```

The > NUL at the end of each line gets rid of the "1 File(s) copied" messages. Notice that the third line not only copies BROWSE.COM to D: but also renames it to Z.COM. That's because Z is a lot easier to type than BROWSE, since Z is one letter long and happens to be at the lower-left hand corner of the keyboard.

SAFETY FIRST Most software packages these days either come with instructions that suggest creating one or more dedicated subdirectories, or have their own installation programs that do it automatically.

However, these automatic installers can be downright dangerous. Some replace your versions of AUTOEXEC.BAT and CONFIG.SYS with their own, when they really ought to modify yours rather than trashing them. Others hide files, which makes it difficult to remove subdirectories.

You can get around the first problem by using the TYPE command or BROWSE or your word processor to examine the .BAT and installation programs. If you see a

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■ HARD DISK ORGANIZATION

■ Some programs, in spiteful attempts at copy protection, install hidden files that you can't see in directory searches.

command that simply copies program versions of AUTOEXEC.BAT and CONFIG.SYS to your hard disk, you can use your word processor to adapt your existing files rather than watching them get trashed.

A smart idea is to maintain a small subdirectory called \BACKUP containing nothing but your current versions of COMMAND.COM, AUTOEXEC.BAT, and CONFIG.SYS. Every time you update one of these, copy it to the \BACKUP subdirectory. Then when a program installs itself destructively you can type

```
COPY \BACKUP \
```

This is shorthand; you could have said

```
COPY \BACKUP\*.* \
```

DOS thinks that when you tell it to perform a task such as copying or deleting and you specify just the name of the subdirectory, you really mean, "do something to all the files in the subdirectory." So if you have a \BIN directory and you type

```
DEL \BIN
```

DOS assumes you want to wipe out every file in the subdirectory, just as if you had typed

```
DEL \BIN\*.*
```

In both cases it will warn you in its quirky way with the message

```
Are you sure (Y/N)?
```

Keeping duplicates of your important root directory files in a \BACKUP subdirectory is also a good idea if you try to get too tricky. While DOS usually pauses to warn

you if you try to delete all the files in a directory, you can sidestep the protection. Execute either of the commands

```
FOR %A IN (*.*) DO DEL %A
```

or, alternatively,

```
ECHO Y | DEL *.*
```

and DOS will merrily wipe out every last nonhidden file. The syntax for the above FOR...IN...DO command is correct if you type it in at the DOS prompt (be careful if you try this). But if you want to use it in a batch file, replace both single % signs with double %% signs (and be even more careful).

Hidden files can be a real problem with subdirectories. Few users end up keeping the same subdirectory structure for very long. Most end up cutting and pasting branches of the tree as they get more sophisticated or desperately short of space, or when they replace applications packages with newer ones.

The RD command removes subdirectories, but only when they're empty. If you've left even one file or lower-level subdirectory in them, you won't be able to expunge the subdirectory.

Some programs, in spiteful attempts at copy protection, install hidden files that you can't see in normal directory searches. If you try to remove a subdirectory that you think is empty and you see a

**Invalid path, not directory,
or directory not empty**

message, first check to see if you've left any subdirectories branching off the one you want to get rid of. If so, you have to move or erase the contents of those lower-level subdirectories first, then use the RD command to remove them.

If there aren't any files or lower-level subdirectories, some nasty application has probably planted a hidden file there. You can check on this by executing the

```
CHKDSK /V | MORE
```

command, which will show all the files on your disk a screenful at a time, including the hidden ones. Then use Charles Petzold's ATTR.COM program (Programming/Utilities Volume 5 Number 11) to unhide the file, or type in the following

script using a pure ASCII word processor. Name it UNHIDE.SCR and be sure to hit the Enter key at the end of each line, especially the last one (with the Q). Also, be sure to leave blank lines above the line with the RCX and the line with the W:

```
N UNHIDE.COM
A
MOV BX,80
INC BX
CMP BYTE PTR [BX],20
JZ 103
MOV DX,BX
INC BX
CMP BYTE PTR [BX],D
JZ 116
CMP BYTE PTR [BX],0
JNZ 106
MOV BYTE PTR [BX],0
MOV CX,20
MOV AL,1
MOV AH,43
INT 21
INT 20

RCX
24
W
N HIDE.COM
A 119
MOV CX,27

W
Q
```

Then put UNHIDE.SCR on the same directory as DEBUG.COM (or make sure that DEBUG.COM is in a subdirectory that you included in your PATH command) and type

```
DEBUG < UNHIDE.SCR
```

This process will give you two new utilities to put in your \BIN subdirectory—HIDE.COM and UNHIDE.COM. To hide a file called BONE, just type

```
HIDE BONE
```

and to unhide it, type

```
UNHIDE BONE
```

One last word of warning. Some particularly evil programs not only hide a file to prevent unauthorized copying, but scramble the way DOS keeps track of it. If you unhide it and then delete it, you may end

■ HARD DISK ORGANIZATION

up with a nastily scrambled hard disk. To avoid this potentially disastrous problem, don't buy copy-protected software—and back up often.

SUBDIRECTORY NAVIGATION It's easy to create new subdirectories and move around inside existing ones if you have the right tools handy and follow a few simple rules.

The first rule is to remember that when you want to move up—toward the root directory—all you have to do is type the simple command

```
CD ..
```

(or `CD..`) to jump you to each successive parent directory. However, when you finally land in the root directory, you can't move up any other levels, so trying to do so will produce an "Invalid directory" message.

What makes this especially easy is the F3 key. If you're in a subdirectory five levels deep called

```
LEV1\LEV2\LEV3\LEV4\LEV5
```

(you will be able to tell this by looking at the `C:\LEV1\LEV2\LEV3\LEV4\LEV5`; prompt that your `PROMPT SP` command displays) and you want to jump back to the root directory, you can do this the easy way, by typing

```
CD \
```

or you can jump upward a level at a time by typing

```
CD ..
```

once and then tapping the F3 key four more times. Each time you do, DOS will repeat the earlier command, and since that command is `CD..` it will bounce you rapidly rootward.

(Get to know the F3 key, since it's a real labor saver. For instance, if you're creating a lower-level subdirectory with the `MD` command, and you make a typing mistake and end up creating one that's spelled wrong, all you have to do is immediately type an `R` and then hit F3. This will send DOS an `RD` (Remove Directory) command to eradicate the erroneous one you just created. The syntax of making and removing directories is identical except for the first letter of the command, and once

```
100 'BATMAKRI.BAS -- by PC Magazine --
110 'This creates easy subdirectory switcher files
120 'Before you use this, get into DOS and type:
130 '
140 '   chkdsk / v | find "Dir" > tempfile
150 '
160 'For this to work properly, make sure each
170 'subdirectory has its own unique name.
180 'To switch between subdirectories in DOS, type
190 'name of the subdirectory WITHOUT the CD\
200 'prefix, and WITHOUT the long PATHname
210 'that usually precedes it.
220 'For instance, to switch to \DOS\BIN, just
230 'type: BIN
240 ON ERROR GOTO 300
250 '--- read raw file, truncate left end of each line
260 OPEN "tempfile" FOR INPUT AS #1
270 IF EOP(1) THEN 370 ELSE LINE INPUT #1,AS
280 AS=RIGHT$(AS,LEN(AS)-12):IF AS="" THEN 270
290 FOR A=LEN(AS) TO 1 STEP -1
300 IF MID$(AS,A,1)<>"\" THEN 320
310 NMS=RIGHT$(AS,LEN(AS)-A)+".BAT":GOTO 330
320 NEXT
330 PRINT "Creating ";NMS;" batch file..."
340 OPEN NMS FOR OUTPUT AS #2
350 PRINT #2,"CD "+AS;:CLOSE #2
360 GOTO 270
370 CLOSE:KILL "tempfile.":PRINT:LIST 160-230:END
380 IF ERR=53 THEN LIST 120-140 ELSE ON ERROR GOTO 0
```

Figure 3: PC Magazine's `BATMAKRI.BAS` program is designed to create individual batch files that let you jump around your subdirectory tree structure by typing in just the subdirectory name without the long pathname that usually precedes it. Before running `BATMAKRI`, make sure `CHKDSK.COM` and `FIND.EXE` are on the path (or are in subdirectories you've included in your `PATH` command) and type `CHKDSK / V | FIND "Dir" > TEMPFIL`

you type in the new first letter, F3 will dredge up the rest.)

To move in the other direction, down from the root directory to `LEV5`, you could, of course, simply type

```
CD \LEV1\LEV2\LEV3\LEV4\LEV5
```

You can't type

```
CD \LEV5
```

since that would tell DOS to jump you into a subdirectory called `LEV5` that was just one level down from the root directory. The real name of the `LEV5` subdirectory above is not `LEV5`; it's `LEV1\LEV2\LEV3\LEV4\LEV5`.

Another way to get there from the root directory is by using the relative version of the `CD` command to bounce you up one level at a time. Note that since DOS keeps track of each subdirectory by its full path name rather than just its particular branch

on the tree, you could have a path like

```
C:\SHARE\AND\SHARE\ALIKE
```

since the subdirectory

```
C:\SHARE
```

is utterly different from

```
C:\SHARE\AND\SHARE
```

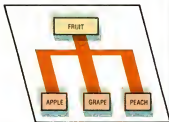
One is a single level down from the root directory, while the other is three levels down. However, having similar names like this is confusing and is a bad idea, for an important reason we'll see later.

To go from the root to the lowest branch one level at a time, you'd type

```
CD SHARE
CD AND
CD SHARE
CD ALIKE
```

When you're on one branch of a tree, it's easy to bounce around from one sub-

directory to another on the same level. If you have a tree that looks like



and you're currently in \FRUIT\APPLE and you want to jump to \FRUIT\GRAPE, you can type in

```
CD ..\GRAPE
```

since the .. is shorthand for the parent directory (\FRUIT).

But jumping from one deep branch of your subdirectory structure to a completely different branch can be a bad typist's nightmare.

If you're currently logged into

```
\FRUIT\PEACH
```

and you want to jump to

```
\PROGS\STAR\VER3\MEMOS\MERGER
```

you'd normally have to type in

```
CD \PROGS\STAR\VER3\MEMOS\MERGER
```

Awful. But there's a far easier trick. If your hard disk is set up properly, you can simply type

```
MERGER
```

and DOS will zap you there.

The trick is to create either a slate of small batch files or one big, big batch file to do all the switching. If you had a batch file called MERGER.BAT on your hard disk, in a subdirectory included in your PATH, with the contents

```
CD \PROGS\STAR\VER3\MEMOS\MERGER
```

typing MERGER would execute the batch file, which would in turn execute the proper thorny CD command. This is why it's a good idea to have subdirectories that avoid confusingly similar names.

You can create a new batch file every time you issue an MD to create a new subdirectory. Or you can run one of the programs in Figures 3 and 4. The program in Figure 3, BATMAKR1.BAS, creates lots of small individual batch files. The one in Figure 4, BATMAKR2.BAS, creates one big batch file. Each has its advantages and disadvantages.

It's far faster to have individual batch files, since they execute quickly. But even though each batch file may be only 20 or 30 bytes long, each takes up whatever the minimum cluster size is on your hard disk.

On an XT running under DOS 2.x, this is a mind-bending 8K. On an AT under 3.x, it's a more manageable 2K. Put a hundred of these small files on your hard disk and you start chewing up valuable real estate.

The advantage of using one big file is that it takes up far less space. The severe disadvantage is that it executes ponderously slowly. This is because one big batch file has to test your input and match it against all the subdirectories on your disk to see which one to switch to. Batch files execute one slow line at a time, so on a slow XT hard disk the process can take 10 or 20 seconds if the subdirectory you want is at the very bottom of the list of tests. If you are tight for space and want to use the one-big-file method, put a command in your AUTOEXEC.BAT file to copy this subdirectory switcher to a RAMdisk, and run it from there.

The other real advantage of having small individual files is that they're more forgiving about typing mistakes. If you tell the long batch file to switch to a subdirectory that doesn't exist, it has to check the one you entered against its entire list, which means chugging its way one line at a time through every test. And, while the one long batch file does at least check for all uppercase and all lowercase entries, it doesn't test for mixtures of upper- and lowercase. It could handle lowercase user input such as

```
merger
```

or uppercase input like

```
MERGER
```

but not Merger, or MErger (a common typing mistake) or something like McrGrE. That's because this method uses re-

placeable parameters, and DOS retains the case of your typing exactly.

With the individual file technique, you're typing in a command (the name of a file, actually) rather than a replaceable parameter. DOS automatically translates commands into all uppercase for you. You should use the shorter individual system if at all possible.

Both versions work from a list of subdirectories you create by typing

```
CHKDSK /V > | FIND "dir" > TEMPFIL
```

The /V switch tells CHKDSK to list all the files on your disk, including subdirectories, which are simply files that DOS codes a special way. DOS then pipes the CHKDSK output through its FIND filter, discarding every line that doesn't have the letters "Dir" in them. This eliminates all conventional files and blank lines, as well as the normal CHKDSK report on the number of hidden files and bytes free.

The longer version creates a single .BAT file to handle all the subdirectory switching. If all you had on your hard disk were a root directory and two subdirectories one level down, \DOS and \BIN, the contents of S.BAT would look something like this:

```
ECHO OFF
IF %1==# GOTO ERROR2
IF %1==DOS GOTO DOS
IF %1==dos GOTO DOS
IF %1==BIN GOTO BIN
IF %1==bin GOTO BIN
GOTO ERROR1
:DOS
CD C:\DOS
GOTO END
:BIN
CD C:\BIN
GOTO END
:ERROR1
ECHO Subdirectory %1 not found.
ECHO Try again.
GOTO END
:ERROR2
ECHO You must enter a subdirectory
ECHO name after %0
:END
```

Both versions require that you have CHKDSK.COM and FIND.EXE on your current directory, or in a subdirectory that you've included in your PATH. Once you've run the CHKDSK/V command mentioned above, run BATMAKR2.BAS to create the long S.BAT file.

If you enter just the name of the batch

■ HARD DISK ORGANIZATION

■ BATMKR1.BAS

creates shorter files
that work far faster
than the long S.BAT.

file you just created, S, with no subdirectory after it, the

```
IF %1@==@ GOTO ERROR2
```

line will jump to the ERROR2 error message. The %0 in this message is a special replaceable parameter that prints the name of the batch file itself in place of the %0. If you change the name of the batch file to something like SWITCH.BAT, this device will handle the new name.

BATMAKR2 automatically creates both a lowercase and an uppercase test. If you entered

```
S DOS
```

or

```
S dos
```

either would jump the program to the :DOS label. The line immediately following the label switches to the \DOS subdirectory and then jumps the program to the :END label so it exits. There are other faster ways to exit, such as having the batch file execute another short batch file, but the delay isn't all that bad on a RAMdisk, and you really shouldn't run this on anything else.

If you enter a subdirectory name that's not in the list of tests at the beginning of the program, you'll jump to the :ERROR1 label, which uses the %1 replaceable parameter to tell you it couldn't find the directory you specified.

BATMAKR1.BAS in Figure 3 is shorter and creates shorter files that work far faster than the long S.BAT. After you run it, to change to \BIN you'd just have to type BIN.

These programs don't offer any fancy way to jump back to the root directory. After all, CD\ isn't that hard to type. And if you're really rabid about it, you can al-

```
100 'BATMAKR2.BAS -- by PC Magazine --
110 'This creates evey subdirectory switcher filee
120 ' (And puts them all in one very long file.)
130 'Before you use this, get into DOS end type:
140 '
150 '      chkdsk / v | find "Dir" > tempfile
160 '
170 'For this to work properly, make sure each
180 ' subdirectory has its own unique name.
190 'To switch between subdirectories in DOS, type
200 ' S end then the name of the subdirectory
210 ' WITHOUT the "CD\" prefix, and WITHOUT the
220 ' long PATHname that usually precedes it.
230 'For instance, to switch to \DOS\BIN, type:
240 ' S BIN
250 'DON'T run S.BAT on a floppy disk. For beet
260 ' resulte, run it on a RAMdisk you've PATHed to.
270 '
280 DIM B$(300),C$(300),F$(300)
290 ON ERROR GOTO 600
300 '--- read raw file, truncate left end of each line ---
310 OPEN "tempfile" FOR INPUT AS #1
320 IF EOF(1) THEN 430 ELSE LINE INPUT #1,AS
330 B$(K)=RIGHT$(AS,LEN(AS)-10):IF B$(K)="" THEN 320
340 FOR A=LEN(B$(K)) TO 1 STEP -1
350 IF MID$(B$(K),A,1)="" THEN C$(K)=RIGHT$(B$(K),LEN(B$(K))-A):GOTO 380
360 NEXT
370 '--- create lowercase version of each test ---
380 FOR D=1 TO LEN(C$(K))
390 F$(K)=F$(K)+CHR$(ASC(MID$(C$(K),D,1)) OR 32)
400 NEXT
410 K=K+1:GOTO 320
420 '--- write upper- and lowercase teete to S.BAT ---
430 OPEN "S.BAT" FOR OUTPUT AS #2
440 PRINT #2,"ECHO OFF"
450 PRINT #2,"IF %1==% GOTO ERROR2"
460 FOR A=1 TO K-1
470 PRINT #2,"IF %1==":C$(A); GOTO ";C$(A)
480 PRINT #2,"IF %1==":F$(A); GOTO ";C$(A)
490 NEXT
500 PRINT #2,"GOTO ERROR1"
510 '--- write actual CD instructions to S.BAT ---
520 FOR A=1 TO K-1
530 PRINT #2,"":C$(A)
540 PRINT #2,"CD"+CHR$(32)+B$(A)
550 PRINT #2,"GOTO END"
560 NEXT
570 '--- write error-handling end ending routine to S.BAT ---
580 PRINT #2,":ERROR1"
590 PRINT #2,"ECHO Subdirectory %1 not found. Try again."
600 PRINT #2,"GOTO END"
610 PRINT #2,"":ERROR2"
620 PRINT #2,"ECHO You must enter a subdirectory name after %1"
630 PRINT #2,":END"
640 '--- cleanup and error routine ---
650 CLOSE:KILL "tempfile":PRINT:LIST 170-260:END
660 IF ERR=53 THEN LIST 130-150 ELSE ON ERROR GOTO 0
```

Figure 4: PC Magazine's BATMAKR2.BAS program is designed to create one master S.BAT batch file to switch subdirectories by typing in the subdirectory name after S. Note the difference from BATMKR1.BAS, which creates small individual files. Run S.BAT from a RAMdisk for best performance. Before running BATMAKR2, make sure CHKDSK.COM and FIND.EXE are on your disk (or are in subdirectories you've included in your PATH command) and type CHKDSK /V | FIND "Dir" > TEMPFIL

ways create a ROOT.BAT batch file that executes this for you.

But how do you know what directories are on your disk?

Simple. Just redirect the output of VTREE into a file called VTREE.PIC with the command

```
VTREE > VTREE.PIC
```

and then create a small batch file called V.BAT:

```
COPY CON V.BAT
BROWSE VTREE.PIC
```

Hit the Enter key after each line, and when finished, hit the F6 function key and then the Enter key one more time.

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PHONE: _____ EXP: _____
CC NO.: _____

■ HARD DISK ORGANIZATION

```

100 ' CD.BAS -- makes C. Petzold's NEXT.COM, DOWN.COM and UP.COM
110 CLS:PRINT "Checking DATA; please wait..."
120 DIM S(12):FOR A=1 TO 12:READ S(A):R=R+S(A):NEXT
130 IF R<17789 THEN PRINT "ERROR IN LINE 260 -- REDO":END
140 FOR B=1 TO 12:FOR C=1 TO 16:READ AS:T=T+VAL("AB"+AS):NEXT
150 IF S(B)<T THEN PRINT "ERROR LINE":B*B+260;" -- REDO":END
160 T=8:NEXT:RESTORE 270
170 OPEN "NEXT.COM" AS #1 LEN=1:FIELD #1,1 AS DS
180 FOR B=1 TO 129:READ AS:LSSET DS=CHR$(VAL("AB"+AS)):PUT #1
190 NEXT:CLOSE:PRINT "NEXT.COM CREATED"
200 OPEN "DOWN.COM" AS #1 LEN=1:FIELD #1,1 AS DS
210 FOR B=1 TO 44:READ AS:LSSET DS=CHR$(VAL("AB"+AS)):PUT #1
220 NEXT:CLOSE:PRINT "DOWN.COM CREATED"
230 OPEN "UP.COM" AS #1 LEN=1:FIELD #1,1 AS DS
240 FOR B=1 TO 15:READ AS:LSSET DS=CHR$(VAL("AB"+AS)):PUT #1
250 NEXT:CLOSE:PRINT "UP.COM CREATED"
260 DATA 934,1655,1762,1501,1538,1326,1391,1902,1195,1758,1839,996
270 DATA EB,0D,9B,2E,2E,0B,2A,2E,2A,00,81,01,00,00,00,0E
280 DATA 81,01,2A,02,B4,47,CD,21,00,3E,81,01,00,74,60,FC
290 DATA 2B,C9,AC,8A,C0,74,0D,41,3C,5C,75,F6,2B,C9,89,36
300 DATA 8A,01,EB,EE,89,0E,0C,01,BA,03,01,B4,3B,CD,21,BA
310 DATA 06,01,B9,10,00,B4,4E,CD,21,72,34,B4,4F,P6,06,95
320 DATA 00,10,74,P3,00,3E,9E,00,2E,74,EC,00,3E,0E,01,00
330 DATA 75,16,0E,9E,00,0B,3E,0A,01,00,0E,0C,01,F3,A6,75
340 DATA D6,C6,0E,0E,01,81,EB,CF,BA,9E,00,B4,3B,CD,21,CD
350 DATA 2B,EB,05,90,2A,2E,2A,00,BA,03,01,B9,10,00,B4,4E
360 DATA CD,21,72,17,B4,4F,P6,06,95,00,10,74,P3,00,3E,9E
370 DATA 00,2E,74,EC,BA,9E,00,B4,3B,CD,21,CD,20,EB,04,90
380 DATA 2E,2E,00,BA,03,01,B4,3B,CD,21,CD,20,00,00,00,00

```

Figure 5: Charles Petzold's program to create NEXT.COM, DOWN.COM, and UP.COM utilities, which let you navigate easily through your subdirectories.

VTREE.PIC every time you create a new subdirectory or remove an existing one. (If you want, you can create another batch file, called UPDATE.BAT, that does this for you and even puts the VTREE.PIC output file into the proper subdirectory.) Then, assuming BROWSE.COM and V.BAT are in a subdirectory that you've included in your PATH, each time you type

V

you'll see an instant graphic representation of your subdirectory tree structure. You can use the cursor and PgUp/PgDn keys to move around in the tree. Hitting Esc will return you to DOS, where you can switch to the target subdirectory by using one of the two BATMAKR methods described above.

If you don't have BROWSE.COM handy and your subdirectory tree is fairly short, you could substitute the command

TYPE VTREE.PIC | MORE

for the line BROWSE.VTREE.PK.

An even better adaptation of this method is to use SideKick's notepad as a window that displays the VTREE.PIC file as

the default. Store VTREE.PIC in your \BIN subdirectory. Bring up SideKick's main menu, and type F7 or S for the Setup menu. Type in \BIN\VTREE.PIC as the new Notefile name and hit F2 to save this as the default. Then whenever you pop up SideKick and select the notepad, the graphic representation will jump onto the screen. For best results, hit QG, which turns on the graphics line characters that connect the subdirectories.

Charles Petzold has written three very short utilities, called UP.COM, DOWN.COM, and NEXT.COM, that can move you effortlessly around your subdirectory tree. To create these, run the CD.BAS program in Figure 5.

UP.COM is a lot like the command CD.. except that if you keep tapping CD.. you'll eventually get to the root directory and receive the "Invalid directory" message mentioned earlier. When UP.COM reaches the root directory it just sits there silently.

DOWN.COM takes you in the other direction, away from the root. NEXT.COM moves you sideways. Try them. You'll like them. NEXT is especially useful when you type it in the first time and then just

lean on the F3 and Enter keys to meander up and down the branches of your subdirectory tree.

FINDING YOUR WAY While these utilities will make it a breeze to find any subdirectory and jump into it, they don't help you find files in your subdirectories.

You can, of course, create a small batch file called FFIND.BAT:

```

ECHO OFF
IF %1==0 GOTO ERROR
CHKDSK / V | FIND "%1"
GOTO END
:ERROR
ECHO You didn't specify a filespec
:END

```

This short file will launch CHKDSK / V into uncovering every file on your hard disk and filter out every filename that doesn't contain the string of characters that you specified. If you enter

FFIND BAS

FFIND.BAT will print a list of every file that ends in a .BAS extension, as well as any file with the letters "BAS" anywhere else in the filename, such as BAS.COM.LIB or BASEBALL.BAT.

But FFIND.BAT is slow, especially on a nearly full hard disk, since it has to pipe hundreds or thousands of filenames through a filter and create temporary files while it does so.

A better choice is to use Michael J. Mefford's SEARCH.COM utility (Programming/Utilities, Volume 6 Number 4), which can search for text inside files as well as the filenames themselves. Or, type in the WHERE.BAS program in Figure 6, which will create a file called WHERE.COM. To use WHERE.COM you must follow it with a legal DOS filespec. While FFIND.BAT lets you get away with entering fragments of filenames, WHERE.COM insists on using full and legal filenames

WHERE COMMAND.COM

or wildcards, as in

WHERE *.COM

FINE-TUNING YOUR SYSTEM While DOS limits the number of files you can shoehorn into the root directory, and smart

■ One final pearl of wisdom is obvious but bears repeating. Think before you FORMAT.

users know to keep their root directories small, the number of files in each of your subdirectories is limited only by the amount of space on your disk.

But it's not wise to let your subdirectories get too big, unless you have an easy way to back them up.

The DOS BACKUP and RESTORE commands aren't very slick, but they're free and can split large files up and spread them over several disks. You can back up incrementally, by having BACKUP copy only files created or changed after a certain date or modified since the last time you backed up. You can tell BACKUP to dig down into your subdirectory structure and can have it overwrite earlier versions or add the new version along with the old.

But BACKUP should format brand-new disks automatically, which it does only in DOS 3.3. And it changes backed-up programs slightly so you can't just run them unless you first RESTORE them. You have to be careful (and use the /P switch) when you're restoring files backed up with earlier DOS versions so you don't write the wrong system files onto your hard disk, though Version 3.3 protects you from this.

Because of all this heartache, many users keep their subdirectories small enough so each can be copied onto a single floppy disk. And they're starting to discover the terrific DOS 3.2 XCOPY command as a better way to create backups. If you work with large files, you have to either grit your teeth and use BACKUP, or buy a tape drive or Bernoulli Box.

Do get into the habit of backing up regularly. The morning you turn your system on and hear a sound like a wrench in a blender, you'll be glad you did.

Backing up just the files you changed or added recently is better than not backing

```
160 ' Program for creating WHERE.COM
110 CLS:PRINT "Checking DATA; please wait..."
120 FOR B=1 TO 27:FOR C=1 TO 16:READ AS:TTL=VAL("B"+A$):NEXT
130 READ S:IF S=TTL THEN 150
140 PRINT "DATA ERROR IN LINE";B*10+190;" -- REDO":END
150 TTL=0:NEXT:RESTORE
160 OPEN "WHERE.COM" AS #1 LEN=1:FIELD #1,1 AS D$
170 FOR B=1 TO 27:FOR C=1 TO 16:READ AS
180 LSET D$=CHR$(VAL("B"+A$)):PUT #1:NEXT:READ DUMMY$;NEXT
190 CLOSE:PRINT "WHERE.COM CREATED"
200 DATA PC,BF,79,82,88,61,88,AC,3C,8D,74,1E,3C,2F,76,F7,1733
210 DATA 88,3E,5C,88,88,74,86,AC,3C,28,76,86,AA,AC,3C,1366
220 DATA 28,77,FA,88,5C,88,8A,C8,75,86,B4,19,CD,21,FE,C8,1867
230 DATA 88,86,27,82,BA,76,82,88,2A,82,88,16,88,88,38,86,1162
240 DATA 82,FF,75,8D,88,82,88,B9,1A,88,B4,48,BA,87,82,CD,1559
250 DATA 21,CD,28,52,8E,79,82,88,86,86,83,88,88,88,72,1725
260 DATA 8D,88,85,88,88,8D,88,72,85,88,7D,88,8D,86,5A,52,1848
270 DATA 8E,23,82,88,8A,88,89,18,88,88,88,88,88,72,3F,88,1623
280 DATA F6,44,15,18,75,8D,88,48,88,72,32,88,F2,86,44,15,1668
290 DATA 18,74,F3,88,7C,1E,2E,74,ED,57,53,88,F2,83,C6,1E,1966
300 DATA 88,FB,AC,AA,8A,C8,75,FA,88,DP,AA,C6,47,FF,5C,88,2681
310 DATA AL,FF,5B,5F,C6,87,88,B4,1A,CD,21,EB,C9,5A,C3,51,2853
320 DATA 83,C2,2C,B4,1A,CD,21,88,EA,B4,4E,BA,27,82,CD,21,1989
330 DATA 88,D5,59,C3,88,EA,B4,4F,BA,27,82,CD,21,88,D5,C3,2288
340 DATA 88,FB,AC,AA,8A,C8,75,FA,C3,88,EA,88,7E,1E,2E,74,2315
350 DATA 22,BA,27,82,32,C8,A2,86,82,86,87,97,88,15,88,97,1497
360 DATA 88,87,88,D5,83,C2,1E,88,EA,88,B4,89,BA,9F,82,CD,1833
370 DATA 21,88,D5,C3,88,F2,84,82,AC,88,BA,CD,21,AC,8A,C8,2273
380 DATA 75,F7,C3,2A,2E,2A,88,4A,3A,5C,88,88,88,88,88,983
390 DATA 88,88,88,88,88,88,88,88,88,88,88,88,88,88,88,88
400 DATA 88,88,88,88,88,88,88,88,88,88,88,88,88,88,88,88
410 DATA 88,88,88,88,88,88,88,88,88,88,88,88,88,88,88,88
420 DATA 88,88,88,88,88,88,88,88,88,88,88,88,88,88,88,88
430 DATA 88,88,88,88,88,88,88,88,88,88,88,88,88,88,88,88
440 DATA 88,88,88,88,88,88,88,88,88,88,88,88,88,88,88,88
450 DATA 8E,67,28,66,63,6C,65,73,28,66,6F,75,68,64,28,8D,1487
460 DATA 8A,24,88,88,88,88,88,88,88,88,88,88,88,88,88,88
```

Figure 6: Program to create WHERE.COM file finder.

up at all, but when your hard disk goes south, you'll have to spend days putting all the little puzzle pieces back together. It's a good stopgap measure, but nothing beats making complete archive copies.

A real alternative to backing up everything at once is that you'll be able to streamline your file structure and end up working far faster. The routine process of adding to and editing down your files each day ends up sowing little file fragments more or less at random over the surface of your disk.

You should periodically copy your files to a backup medium (and get rid of the duplicates, BAK versions, and dead data in the process), reformat your hard disk, and then copy everything back. You'll notice an immediate improvement in speed. When you do this, put the subdirectories that you PATH to at the very beginning of your directory by making sure they're the first ones you copy to the newly formatted disk.

One final pearl of wisdom is obvious but bears repeating. Think before you FORMAT. Even though the latest versions of DOS make you type in a Y and then hit the Enter key before letting it go ahead and wipe everything out, late at night you may misinterpret the question or hit a Y when you mean N, or have some aberrant and lethal combination of JOIN, APPEND, and SUBST bubbling away under the surface that steers an innocent floppy request into a jolt of panic.

A few seconds into the formatting process the hard disk FATs and directories get zeroed out, and any attempt at resurrection is only a best guess. It is possible to bring much of your data back to life with a utility like Mace's or Norton's, especially if you let Mace park a copy of your FAT ahead of time. But don't tempt fate.

If you're working on something time-sensitive and critically important, stop frequently while you're working and make a working copy on a floppy. It is possible to

HARD DISK MANAGERS

Here are excerpts of the reviews of three disk managers previously chosen as PC Magazine Editor's Choices.

If you don't have the time or inclination to assemble programs that will maintain your hard disk directories, a commercial hard disk manager might be the solution to your storage management problems.

A variety of programs that tend to be grouped into the category of DOS shells can help to manage the arrangement of the subdirectories on your hard disk. Many of these programs extend DOS's utility and allow deletion, file moves, and subdirectory creation much more efficiently than DOS can by itself.

In a recent article ("DOS Shells Get Smarter," *PC Magazine*, Volume 6 Number 4), we looked at 20 such programs. The reviews of the Editor's Choices we selected are excerpted here.

dirWORKS

Keep It Simple Software's *dirWORKS* does just that as it guides you around your hard disk. The interface—one main screen and pop-up, task-oriented windows—is straightforward. You select most disk management options and files simply by pointing or typing the first letter.

The included file management features permit all of DOS's commands, such as COPY and DEL, as well as allow you to move and tag files. You can tag by date and time, a very useful feature if you are in the habit of doing backups.

dirWORKS's other features include an information screen, which displays the type of system you're using, the number and type of drives and ports, and the amount of installed and free memory; a handy format option that simplifies for-

matting 360K disks on a 1.2-megabyte drive; and the ability to execute programs with parameters.

All in all, *dirWORKS* is a program to consider if you are looking for ease of use and an excellent price/performance ratio.

DOS2ools

Unlike the other two programs mentioned here, E-X-E Software System's *DOS2ools* allows fans of the DOS prompt to keep it in sight as they handle their file management tasks. The program is a set of 43 powerful and intelligent utilities that can be evoked directly from the prompt or through a friendlier interface that displays all the tools in a set of six "drawers."

Two commands in the General Tools drawer, Move and Where, prove themselves invaluable. Both operate quickly and efficiently with a minimum of information. In the same drawer are commands for running 1-2-3, displaying the size of files in a directory, and showing statistical information about the system's memory.

There are programmer's tools for linking and unlinking files and for altering disk and RAM contents. The Bmarx utility will benchmark-test your CPU's performance and display the number of wait states. If you don't have a copy of the PC Magazine Labs benchmark tests, the Bmarx utility is an excellent alternative.

Other utilities encrypt files, create macros, and excise columns from text. You may not need to use all 43 utilities in the package, but you'll love the ones you do use. If you have to get one program and you're not afraid of the DOS prompt, *DOS2ools* is for you.

ning patching together little shards of your work that you've fished out of the magnetic mark.

If you notice that performance is degrading, or hear the percussive rhythm of repeated read retries, run Norton's DISK-

X-Tree

Executive Systems' *X-Tree* has long been a favorite of hard disk users who like to see a graphic representation of their hard disk. Installed in a few simple steps, *X-Tree* splits the screen into seven windows, the largest of which displays a graphics tree depicting the arrangement of the disk's subdirectories.

A second window displays files currently in the highlighted directory; either window can be scrolled to show more files. To the right are small windows that list disk and directory statistics: bytes, number of files, available space, and so on.

All command options that are displayed on the screen are selected by typing the first letter of the command, and while these commands can't do everything, they make easy work of the more important DOS commands: DIR, DEL, COPY, TYPE, REN, MKDIR, RMDIR, CHDIR, and VOL. *X-Tree* permits tagging files (for batch operations), printing files or the tree structure, and sorting files by a number of criteria.

X-Tree can manage no more than 2,500 files and 180 directories, and you need to be careful when using the program, as one careless keystroke could wipe out dozens of files. But all in all, *X-Tree* is a gem. It's fast, smooth, and easy to learn, and it showed no compatibility problems with RAM-resident programs. At less than \$50, this program will help clear up an awful lot of hard disk confusion.

—Donald P. Willmott

Donald P. Willmott is an editorial assistant at PC Magazine.

corrupt a hard disk if you're writing to it and the local power company decides that moment would be a good one to switch generators. You can set up a batch file to automate the process. Otherwise you might end up spending the rest of the eve-

TEST program. This takes a few minutes, but can ferret out developing programs and zap out bad sectors better than DOS can. And if the Norton program reports grief, back up everything pronto and hie down to your dealer. When hard disks start whim-

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dirWORKS

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(212) 398-1286

List Price: \$25, plus \$5 shipping and handling.

Requires: 256K RAM, one disk drive, DOS 2.0 or later.

In Short: An excellent shell that uses pop-up menus and provides all of the power you need without imposing on your work habits. Not copy protected.

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DOS2ools

E-X-E Software Systems
8855 Atlanta, #298
Huntington Beach, CA 92646
(714) 662-2535

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In Short: An excellent collection of 43 robust, intelligent utilities that will enhance not only DOS's performance but yours as well. Not copy protected.

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X-Tree

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15300 Ventura Blvd., #305
Sherman Oaks, CA 91403
(800) 634-5545
(800) 551-5353 (in Calif.)

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pering, they go downhill real fast. Hard disk problems never just go away. ☐

Paul Somerson is an executive editor of PC Magazine and the editor of User-to-User.

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2 073	INSURANCE BEG BAL MTD	2,149.65	2,145	
2 073	FORCE-CLOSE LOSS BEG MTD	0.07	0	
2 073	LOANS IN PROCESS BEG BAL	27,337.77	27,337	
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2 073	SECONDARY INT EARNED MTD	6.78	15	
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BIG DRAWS: THE NEW LARGE-FORMAT PLOTTERS

In the 2 years since *PC Magazine* began reviewing plotters, there have been several changes in the market. The desktop market has experienced a shakeout in the number of manufacturers participating and a reduction in the number of new units introduced. Improvements in dot matrix technology allow the production of reasonable-quality hard copy, even in

.....

The newest plotters, both large-format and desktop-size, are sleek and elegant machines that offer vast improvements on the technology, design, and general output quality of their ancestors.

CHOOSING A PLOTTER PEN

If you match the type of pen to your choice of media, the results will be fine.

Stick some paper in, throw in a pen or two, and let 'er rip. That's all there is to plotting, right?

Well, it can be almost that simple, but there's usually more to making informed choices on the supplies you use to produce those elegant and impressive graphics images. Fortunately, the options aren't all that complicated once you understand the issues involved and how your decisions interact.

Plotter pens are available in several styles, differing in such factors as the material forming the tip, the width of the line drawn, and the composition and color of the ink. The most-common tips are fabricated from nylon fibers, plastic, steel, and tungsten, sometimes with variations like ceramic cladding.

Fiber-tip pens are inexpensive, draw vivid colors with fairly good line quality, and can draw at reasonably high speeds. Water-based versions are used for plotting on paper, while oil-based ink is used for overhead transparencies.

Ballpoint pens are convenient and can draw at high speeds.

Some ballpoints pressurize the ink for even faster plot speed. They offer good line quality, but they're not as vivid or as effective in filling large solid areas.

The best line quality is obtained from liquid-ink pens. Two types are common: refillable and disposable. Refillable liq-

uid-ink pens are replenished manually from a bottled ink supply. Since the ink dries out quickly and can solidify within the pen, such pens require constant cleaning. Disposable liquid-ink pens provide all the benefits of liquid ink in a much more convenient, albeit costly, form. Both types must be run at significantly slower speeds to allow even ink flow.

There are also many types of media. Users of small desktop plotters often use common bond or copier paper, but this is not a particularly good move. The surface of copier bond is not especially smooth, and delicate plotter pens can be abraded and roughened by the paper surface, leading to reduced line quality.

Bond papers with smooth surfaces are available and are good choices for everyday use. Coated bond stocks (available in either flat or glossy finishes) can be even better, and there is also an uncoated bond called tracing stock, which is acceptable for preliminary output.

Transparency film is a clear plotting medium suitable for use with overhead projectors. The surface is not absorbent, so special inks and very slow plotting speeds are necessary to assure good line quality and avoid smearing.

Most serious CAD work is done on vellum, a special form of paper coated for maximum smoothness. Vellum is

chemically treated for extra strength and transparency. Its main drawback is higher cost.

All paper is subject to expansion and contraction with changes in humidity and temperature. Where dimensional stability and long-term archival permanency are critical, plotting is often done on matte-finished polyester film. This translucent material also has a fine coating that makes it more receptive to ink.

Your choice of media dictates the appropriate type of pen. For example, you can use fiber-tip and ballpoint pens with plotter paper and tracing bond, while transparency pens are designed for overhead film and can also be used with glossy paper. Liquid-ink pens are most often used with vellum and polyester film, though the disposable liquid-ink pens also give good results on plotter paper. The rough surface of matte film would wear normal tips down quickly, so harder tungsten tips, which can stand up to the punishment, are available.

In general, if you match the type of pen to your choice of media, results will be fine. Many high-end plotters also make the necessary speed and down force changes automatically by sensing the type of pen inserted into the plotter, but you should be sure to adjust plotting speed if your plotter doesn't offer this handy feature. —Glenn Hart

color, on small printers. Laser printers with sufficient memory for graphics continue to decline in price as well. Both these plotter alternatives have the ability to perform normal printing functions. Plotters offer the highest graphics quality and flexible color capability, but they are solely graphics devices.

Hewlett-Packard dominates the desktop plotter market, with Houston Instrument a distant second. HP's stranglehold has forced the manufacturers of some very competent small plotters out of the market. For example, Epson America (whose HI-80 A-size plotter was designated an Edi-

tor's Choice by PC Magazine), Apple, and Facit are closing out their plotters (you may be able to buy such units at bargain prices while they last).

The real action has moved to the larger D- and E-size plotters. These devices are used primarily for computer aided drafting/design (CAD) and engineering output. CAD is one of the hottest microcomputer software categories, and as small computers provide more and more computing horsepower, micro CAD software offers increased functionality to match systems previously costing an order of magnitude more. Happily for the plotter manufactur-

ers, almost all these systems need plotters.

While Hewlett-Packard plays a major role in the large-size plotter market, several competitors boast healthy market shares too. This competition and the growth in the large-plotter segment have led to significant research and development efforts that are now bearing fruit in new generations of high-performance plotters. The new designs often are less costly to produce while retaining or even improving on past performance levels. These manufacturing efficiencies and the competitive environment have also reduced prices significantly, bringing plotters to a wider audience.

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■ PLOTTERS



Plotters: Summary of Features

(Products listed in ascending price order)

EXPLANATION OF FEATURES Plotters are categorized according to the maximum paper size they can accommodate. Size A is 8 1/2 by 11 inches, B is 11 by 17, C is 17 x 22, D is 24 by 36, and E is 36 by 48. Paper movement distinguishes between flatbeds, where the pens move over stationary paper, and roller beds, usually found on large plotters where the media rolls beneath the pens as they draw. Various types of **paper hold systems** are used, including electrostatic, magnetic, grit wheel (which holds the media in place with friction), and pinch roller (which requires special media with printer-like guide holes on the edges).

Number of pens is self-explanatory. **Pens auto-capped** refers to automatic pen-capping capability, which is necessary to prevent drying of the pen tips. **Maximum pen speed** is the fastest speed (rates can vary depending on whether the pen is moving diagonally or along the x or y axis). Almost all plotters allow for **adjustable pen speed**, but, while some let you specify any speed within their range, others can adjust speed only in fixed increments, which are sometimes set by switches rather than by software. **Step size and accuracy** are the major determinants of a plotter's ability to create sharp and detailed plots. Step size is measured in either the number of steps per inch or by a distance measurement. Theoretically, the more steps per inch, the better the resolution. The measure of accuracy here is the percentage of accuracy over a long pen move. **Buffer size** shows the amount of RAM built into the plotter itself for storing instructions. Some of the plotters tested let you add RAM to expand the buffer size. **Optimization** indicates whether a plotter includes a system to decrease the length of time a plot requires. Some plotters allow digitizing by letting you move the pen head to a desired position with cursor keys, then send its position coordinates to the computer by hitting a key on the operator panel, hence the **acts as digitizer** entry. **Auto paper feed** indicates capability for producing a sequence of plots without manual intervention by using a batch process (the graphics software in use must also allow this; most business graphics and CAD programs currently do not).

The interface section shows what type of interfaces are available or standard. Most personal computers use either serial RS-232C or parallel Centronics interfaces. The IEEE interface, also known as GPIB (General Purpose Interface Bus) or HP-IB (Hewlett-Packard Interface Bus), is designed primarily for scientific and control applications. The programming section lists graphics command languages. HPGL, the Hewlett-Packard Graphic Language, is emerging as a de facto standard. Proprietary indicates a manufacturer's own command set. Other indicates that a manufacturer chose to emulate a graphics language other than HPGL. **Bundled software** indicates whether any commercial graphics software is included with the plotter.

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	Roland DXY-865	Roland DXY-990	Imaje LP4000	CalComp 1041 GT	Bruning Zetadref 900	HP Draftmaster I
PHYSICAL SPECIFICATIONS						
List price	\$1,695	\$2,295	\$5,495	\$6,495	\$7,950	\$9,900
Paper movement	Flatbed	Flatbed	Roller bed	Roller bed	Roller bed	Roller bed
Maximum paper size	B	B	E	D	E	E
Paper hold system	Magnetic	Electrostatic	Grit wheel	Grit wheel	Pinch roller	Grit wheel
Number of pens	6	8	20	8	8	8
Pens auto-capped	●	●	●	●	●	●
Maximum pen speed (inches per second)	11.8	11.8	26	24	45	24
Pen speed adjustable	●	●	●	●	●	●
Step size (inches)	.001	.001	.001	.0005	.0005	.001
Accuracy (percent)	.1	.1	.5	.1	.05	.085
Buffer size	1K byte	1K byte	6K bytes	2K bytes	40K bytes	25K bytes
Optimization	○	○	Optional	Optional	○	○
Acts as digitizer	●	●	●	●	●	●
Auto paper feed	○	○	○	○	○	Optional
Weight (lbs.)	12.8	14	50	150	135	160

INTERFACE

Serial	Standard	Standard	Standard	Standard	Standard	Standard
Parallel	Standard	Standard	None	None	None	None
IEEE	None	None	None	Optional	Optional	Standard

PROGRAMMING

HPGL	●	●	○	Optional	●	●
Proprietary	○	○	○	●	●	○
Other	○	○	DM/PL	○	2 others	○
Bundled software	○	○	Utilities	○	○	○

●—Indicates Editor's Choice ●—Yes ○—No

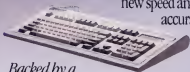
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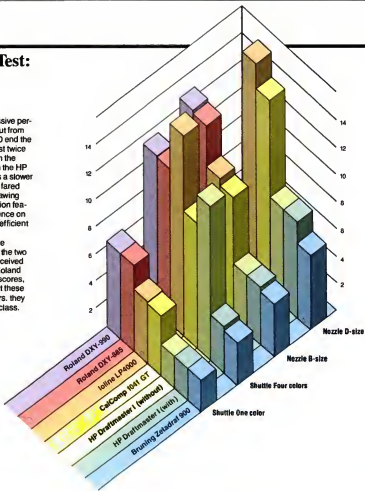
■ PLOTTERS



Benchmark Test: Plotters

All the plotters turned in impressive performances, but some stood out from the rest. The Bruning Zetadraf 900 and the HP Draftmaster I were both at least twice as fast as the rest of the pack, with the Bruning running a little faster than the HP on most tests. The HP, which uses a slower pen-handling system, would have fared poorly on the four-color shuttle drawing without its standard pen optimization feature. The Bruning's swift performance on the four-color test is a result of its efficient pen handling.

The CalComp 1041 GT and Ioline LP4000 ran at best half as fast as the two leaders, but neither plotter was received with its optimization option. The Roland plotters had the least impressive scores, but it's important to remember that these are smaller, less expensive plotters; they are good performers in their own class.



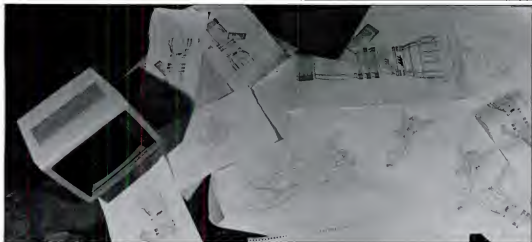
Performance Times (Times given in minutes)

	Shuttle One color	Shuttle Four colors	Nozzle B-size	Nozzle D-size
Roland DXY-990	6.3	11.4	12.7	N/A
Roland DXY-885	6.3	11.3	12.5	N/A
Ioline LP4000	4.5	14.7	9.5	15.9
CalComp 1041 GT	4.4	9.2	9.0	14.1
HP Draftmaster I (without optimization)	2.3	11.3	4.2	7.0
HP Draftmaster I (with optimization)	2.3	3.4	4.2	7.0
Bruning Zetadraf 900	2.4	3.1	3.9	5.5

The **Plotter Speed** benchmark test assesses the time required to draw a nozzle image in B and O output sizes, and a space shuttle image in one and four colors in the B-size format. The test is conducted using an 8-MHz IBM PC AT with 640K bytes and an 80287 math coprocessor. Autodesk's AutoCAD, Version 2.5, is used to generate the images.

N/A—Not applicable; does not produce D-size plotter output.

Results show the time in minutes the plotter takes to complete the images. AutoCAD's plotter optimization feature is disabled, but plotters equipped with built-in optimization are timed with and without the feature. The plotters are tested at their highest operating speed, using parallel interfaces where possible.



	Nozzle B-size	Nozzle D-size	Shuttle One color	Shuttle Four colors
Roland DXY-890				
Roland DXY-885				
Ioline LP4000				
CalComp 1041 GT				
HP Draftmaster I (without optimization)				
HP Draftmaster I (with optimization)				
Bruning Zetadraf 900				

Let's talk tips &

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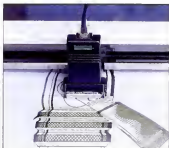
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HOUSTON INSTRUMENT SCAN-CAD

Scan-CAD uses the plotter's mechanics to move an optical head over a large CAD image and derive the raster data needed for input to the CAD/camera software.

Scanners are optomechanical devices that convert a printed image into data that can be used by graphics software, often to avoid manually reentering the image into a computer. There are several variations on this general theme, depending for the most part on the requirements of the software and the type of material being scanned. The new wave of desktop scanners are primarily used for importing printed images into desktop publishing programs, but they can also be used for optical character recognition to scan printed text with appropriate software.

There is also a long history of scanner use with large CAD systems. New CAD installations often have a huge inventory of hand-drawn images, some of which must be entered into the CAD system for revision. Scanning can save manual reentry, but there are problems. Converting scanner output into a form usable by CAD software is a slow and primitive process. Usually, quite a bit of correction



In the Scan-CAD system, an optical head (pictured above) rides on the rail of a Houston Instrument plotter, scanning the image at 2 to 8 inches per second.

must be performed by hand.

Scanners produce what is called raster output since the data represents a series of bits along one thin line, much like the raster in a monitor or television. CAD programs work with vector representations, in which the entities in the image are lines, arcs, and the like described mathematically rather than as a pattern of dots. Last year, *PC Magazine* reviewed a software package called *CAD/camera* from Autodesk, supplier of *AutoCAD*, which performs the necessary raster-to-vector conversion.

However, small desktop scanners simply can't accommodate large CAD drawings, and scanners that can deal with E-size CAD images have generally cost at least \$40,000.

Now Houston Instrument, long well

regarded for its plotters and digitizers, has introduced a possible solution. The Scan-CAD, an attachment for any of its DMP-50 series plotters, that uses the plotter's mechanics to move an optical head over a large CAD image and derive the raster data needed for input to the CAD/camera software.

The Scan-CAD system includes a full-length PC circuit board that interfaces the optical head to the computer. The card doesn't use any normal serial port, though the serial port that the plotter is normally connected to is still used as well. A full 640K bytes of RAM is needed, as is a hard disk to store the large data files created by any such system. A CGA, EGA, or Hercules video adapter is desirable, since you can preview a portion of the image graphically, but it's not at all mandatory.

The Scan-CAD is capable of 200-dot-per-inch resolution. Some scanners can manage 300 dpi, but 200 dpi is more than adequate for most CAD applications. The system can detect two-line pairs of about .2 millimeter width in 1 millimeter, which is very fine performance.

The CPU power of the host computer determines the maximum velocity of the scan. An XT-based system can scan at 2 or 3 inches per second, while an AT allows scanning at up to 8 ips.

The supplied software, which controls the scanning process, is menu-driven and easy to use. Three main steps are required to scan an image. First, you set scan parameters and preview a small por-



FACT FILE

Houston Instrument Scan-CAD

Houston Instrument
8500 Cameron Rd.
Austin, TX 78753
(512) 835-0900
List Price: \$2995

In Short: Scan-CAD does an excellent job of scanning E-size plots.

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CATEGORIZING PLOTTERS The major distinction between plotters is the size of the paper or film media they can handle. There are various systems to designate media size, but the most common is a lettering system in which normal 8½-by-11-inch paper is called A-size, 11 by 17 is B, up to E-size at 36 by 48 inches or so. For the most part, the larger the media a

plotter can use, the more costly the plotter.

There are plotters with maximum sizes in all the letter categories. Small plotters that fit on a desktop surface usually accommodate maximum media of either A- or B-size, and are used primarily for business graphics like presentation charts, overhead projection transparencies, and the like. Large, floor-standing D- and E-size plot-

ters are used mostly by architects, mechanical and electrical engineers, and other professionals.

There are two main design strategies prevalent in modern plotters. Flatbed plotters have a large, flat surface onto which the medium to be plotted upon is fastened. The pen mechanism moves along a fixed rail on one edge while a pulley system

tion of your image (if you have a suitable graphics card) to assure that everything is configured correctly. Then you actually scan the image. Finally, the raster file created by the scan is converted to the format required by *CAD/camera*. You then can invoke *CAD/camera* itself and convert the raster image to an *AutoCAD* .DFX file for use with *AutoCAD*.

This process can take a while. HI claims an A-size image can be scanned in 2 minutes, while a full E-size scan is specified to take 24 minutes. PC Labs tests confirmed these scanning times, and we found HI's conversion to *CAD/camera* format was quick as well. *CAD/camera* itself can take hours for a large image, but end of the process is acceptably fast.

The Scan-CAD assembled easily by simply following the clear documentation. HI's software is straightforward and almost intuitive, and it performs exactly as expected. An editing program, which will allow manipulating the raster files created with the Scan-CAD prior to conversion, will be supplied to all Scan-CAD owners sometime in the second quarter of 1987.

The only difficulty we experienced was in scanning a B-size image drawn on fairly light stock. HI warns that the original can be mangled a bit and suggests mounting small originals on a carrier that is supplied with the system. We did manage to crease the small original when we didn't listen and scanned it directly, which also ruined the scan accuracy be-

cause the strips didn't line up correctly. We had no problems at all when the carrier was used or when we scanned an E-size original.

Scan-CAD works as advertised. You'll need *CAD/camera* too, which currently costs \$3,000, but the combination is still less costly than anything else that can import a full E-size image. You're also limited to the DFX format, which several CAD programs besides *AutoCAD* can also import.

Even though the product is obviously aimed directly at the CAD market, I wish the system could produce files suitable for paint and desktop publishing programs. Desktop publishing is a boon to technical and documentation writers, and even though you can export an *AutoCAD* image to some desktop publishing programs, this adds several layers of extra processing and time compared to direct output from the Scan-CAD system. Houston Instrument tells us it is working with various vendors to both encourage support of the Scan-CAD and to determine what data formats HI might generate, and so greater compatibility is definitely in the cards.

The Scan-CAD system also obviously works only with plotters. Since PC Labs has designated its DMP-51 and DMP-56 plotters as Editor's Choices in past reviews, this is hardly a terrible hardship. The DMP-50 series plotters are fine devices, and the availability of the Scan-CAD increases their desirability even more. —Glenn Hart

moves the pen along the other axis. In this way, the pen can access and draw on any portion of the medium.

Flatbed plotters keep the medium completely stationary. The same results can be achieved by moving the medium in one axis while a pen moves perpendicularly in the other axis. The first devices to use this concept were called drum plotters, be-

cause the medium was actually wrapped around a large drum and fastened securely at opposite edges.

The drum design has been superseded by a variation that grasps the medium at two opposite edges with rubber or metal pinch rollers or capstans. These rollers are often coated with a gritty material or are scored to ensure that they don't slip. The

medium moves forward and back through this friction, while the pen mechanism moves from side to side along a fixed rail. We coined the designation "roller-bed" to distinguish this type of plotter from flatbed designs, and the term seems to be gaining popularity.

Both types of plotters must ensure that the medium is exactly where it is supposed to be at any given time during the plotting process.

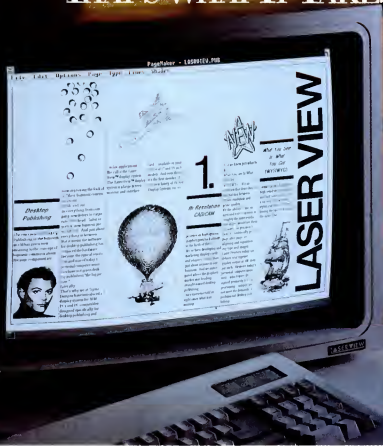
Flatbed designs must keep the medium both perfectly stationary and perfectly flat against the plotting bed. Plots could be ruined if either the medium shifts position or if a pen grazes against a raised area of the medium as it moves over the surface. There are several methods used to hold the medium down. The simplest techniques include simply taping the medium in position or including sticky strips on the plot bed. Neither method is particularly attractive; it can be difficult to remove tape, and the sticky strips on some plotters are liable to get dirty and lose their grip. Other plotters employ a magnetized metallic bed, so thin metal strips can be placed around the edges of the medium to secure it in place. This works a little better, although you must be careful not to place any magnetic storage medium like a floppy disk on the plotter, lest it be irrevocably damaged.

The best flatbed devices can apply a static charge to the bed. This electrostatic system causes the medium to cling tightly to the bed, and it is simple and effective. Its only drawback is added cost.

While it's not easy to hold the medium in position perfectly, it's even more difficult to move sheets of medium forward and back at high speed with precisions measured in thousandths of an inch. The roller mechanisms on roller-bed designs attempt to grasp the medium very tightly so that they can control medium movement accurately. The rollers on some plotters are fixed in position, while others are movable to allow plotting on various different media sizes. One alternative design moves specially perforated media with a tractor mechanism similar to that used in many printers.

PENS Plotters also vary in the number of pens they can use. Plotters that can store and access multiple pens are obviously

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■ PLOTTERS

more costly than single-pen designs. Most software can be instructed to pause if a pen change is required, so it is possible to produce multicolor plots even on single-pen plotters, but it is inconvenient and time-consuming to stand around waiting for the pen changes instead of letting the plotter do the pen-changing itself.

There are two main systems of storing multiple pens. The simplest merely lines the pens up in stalls along one edge of the plotter. The pen head moves to a stall to grasp or return a pen. A similar design uses a rotating carousel to store the pens. The carousel rotates until the desired pen is in position for the pen head to grasp as it approaches.

Both these methods require the pen head to move to the stall or carousel location, which takes a finite time that depends on how fast the pen head can move. Other multipen designs store the pens at the pen-head itself, often in a rotating carousel, so the pens move along with the head as it performs its plotting chores. This eliminates the need to move to the stall area, which can save significant time if there are many pen changes.

All pens can dry out if their tips are exposed to the air. Some types of ink dry much more quickly than others, but capping the pen tips is highly desirable in all cases. Fortunately, most plotters now include some provision for capping the pens while they're not being used to draw—usually some sort of rubber grommet that surrounds the tip and seals it from the air while a pen is stored in the stall or carousel.

Almost all plotters now include a graphics language in ROM that includes instructions to draw the various entities that make up a finished plot. This makes the task of the graphics software driving the plotter much easier, since it can merely say something like "draw a circle of this diameter in this position" rather than issuing detailed pen movement instructions.

By far the most common plotter language is Hewlett-Packard's HPGL. Many plotters from different suppliers emulate this language, which improves compatibility. Houston Instrument's DM/PL also has adherents, and several other plotter manufacturers have proprietary plotter languages in their devices. Most CAD pro-

grams support all the popular plotter languages, but spreadsheets, business graphics programs, and other software are sometimes limited to HPGL. You should be sure that the software you will be using supports the graphics language in your plotter.

SUMMARY All mechanical devices have trade-offs, but a plotter's compromises are more obvious than most. You'll pay more for plotters that can handle larger media, plot faster, handle more pens, and so on. With any plotter, the best quality is obtained with slower plotting speed and with pens that are both more expensive and sometimes messier. Better results are possible with more costly medium, and so on, and so forth.

Fortunately, it's quite difficult to buy anything other than a competent plotter these days. The price-to-performance ratio varies from unit to unit, though, and hopefully the evaluations here and in our previous reviews will help you make the best decision for your circumstances.

BRUNING COMPUTER GRAPHICS Bruning Zetadraf 900

PC Magazine has tested two earlier Zeta plotters, from Bruning Computer Graphics, with excellent results. The Zetas are well known in the mini and mainframe communities, but less so in the microcomputer arena, partially because they have been a bit on the pricey side.

Not so the new Bruning Zetadraf 900. The Zetadraf offers very fast plotting and high-end features but is thousands of dollars less costly than Bruning's previous models and competitive plotters.

Styling is very modern and attractive. Large flat feet keep the plotter steady, but the Zetadraf is so heavy that some users may miss casters. The sharply angled right support not only looks spiffy, but it places the operator panel in a most convenient spot.

Bruning supplies a customized IQ Technologies Smart Cable with every Zetadraf. Smart Cables are wonderful gadgets that correctly interface many computers and peripherals, and the inclusion of one with the Zetadraf is a commendable



FACT FILE

Bruning Zetadraf 900
Bruning Computer Graphics
777 Arnold Dr.
Martinez, CA 94533
(415) 372-7568
List Price: \$7,950

In Short: The Bruning Zetadraf 900 is stunningly styled and of exceptional quality. At \$7,950, it's a bargain.

CIRCLE 6 ON READER SERVICE CARD

solution to serial cable headaches. The supplied cable worked perfectly with our test AT.

The operator panel is deceptively simple-looking. A four-line by 20-character LCD display is flanked by four "soft buttons." Each button corresponds to one line of the display, and the function of the buttons changes as the display does. This allows a small number of buttons to simulate a much more complex panel. The panel also has buttons for pen selection and movement and to invoke Zips, a form of user-defined macro that can shortcut the normal setup process.

Navigating through the Zetadraf's menu structure is somewhat more confusing than similar competitive designs, but the scheme begins to make sense after a little use. You can use a default set of parameters to get started, but you'll want to define your own set of operating conditions. You can store a new setup temporarily or retain it in the Zetadraf's nonvolatile memory; up to six configurations can be named and easily recalled.

The list of options you can set is impressive. The Zetadraf supports Bruning's own GML (Graphics Machine Language) and Hewlett-Packard's HPGL, as well as Tektronix PLOT 10 and CalComp 960 emulation. You can cut and paste, rotate, scale, or mirror incoming plots; adjust all communications parameters; select between vellum, glossy, bond, and matte film media; align the plotter to gridded media, and specify nearly all aspects of pen movement speeds and forces.

Four types of pens are available, including nylon fiber, liquid roller, and liquid ink with either stainless steel or tung-

■ PLOTTERS

sten tips. The pens are actually bodies that hold ink cartridges in various colors. Each body can be used for two ink carts before Bruning suggests retiring it to ensure that tip deterioration doesn't degrade plot quality. The Zetadraf's pen carriage holds eight of the slender pens that travel along with the pen head while a plot is drawn. The Zetadraf's head doesn't have to return

to a carousel or stall to retrieve pens, which reduces plot time in drawings with many colors.

Gripper wheels hold the medium in place, assisted by vacuum hold-down. The right wheel is movable, so the Zetadraf can plot on any size media up to E-size. The plotter senses media size when you hit the Load button, so there's no need to inform

the device of the size of the media you've inserted.

Most users will probably use the Zetadraf in its HPGL emulation mode, but Bruning offers a special GML driver for AutoCAD, which it claims is somewhat faster than HPGL emulation. We tested both and confirmed that the GML driver was about 10 percent faster.

Three predefined plot quality modes are provided, which Bruning designates Good, Better, and Best. You can, define your own custom set of quality parameters, including differing quality ratings for individual pens. The trade-off is that the better the quality, the slower the plot. We were a bit surprised to find that the differences in quality were rather noticeable, but the timings, given in minutes/seconds, did not differ all that much:

	GML B Nozzle	GML D Nozzle	HPGL D Nozzle
Quality			
Good	3:54	5:27	5:55
Better	4:03	5:43	6:11
Best	4:20	6:08	6:43

While the timing differential between quality settings might be greater with more-complex images, clearly the time savings are not that great. If we were using the Zetadraf every day, we would rarely use anything other than the Best setting.

The plot of the B-size shuttle took 2:23 in monochrome and 3:06 with four colors. This is a relatively small difference, highlighting the efficiency of the pens-move-with-the-head design.

While these speeds are impressive, plot quality was only very good, perhaps a tad below that of some other high-end plotters. Operation was unusually quiet. Vacuum hold-down was effective in maintaining media flatness in the writing area, although on a couple of occasions we experienced some slight media slippage.

The Zetadraf is a brand-new model, and the very slight deviations from perfection that we experienced may be ironed out as the product matures (we've been very pleased with the output quality of previous models in the Zeta line). Overall, the Zetadraf is an extremely impressive device. It is the sexiest plotter we've ever seen, and its beauty is far more than skin deep. It's



The dynamically styled Bruning Zetadraf 900 is a top-notch performer that is worth the almost \$8,000 price tag. The operator panel (left) has a four-line by 20-character LCD display flanked by four buttons that are programmed to provide a wide variety of functions.

AW...

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■ PLOTTERS

fast, flexible, and very reasonably priced (at \$7,950) compared with competitive units from HP, CalComp, and others. The Zetadraf 900 may well be the best value in E-size plotters available.

CALCOMP

CalComp 1041 GT

CalComp's new 1041 GT plotter is a lower-cost version of the E-size 1043 GT PC Magazine reviewed so favorably last year. We were impressed with the 1043's speed, flexibility, and overall quality, and the 1041 is definitely cut from the same cloth.

While the CalComp 1041 GT plots only up to D-size, it is actually the same size as the other, E-size plotters in CalComp's 104x series; the roller drum in the 1041 GT is configured to allow only the smaller plots. CalComp saved money by not having to design and manufacture a completely new design, but the 1041 GT is physically larger and heavier than most D-size plotters as a result. It is also somewhat frustrating to see all that unusable space.

There are several other differences that also account for the lower price. For example, the 1041 GT doesn't have the optimization buffer system that greatly improves plot times on the 1043 or the joystick that's handy for moving the pen head. You can add the optimization for \$500 and the joystick for \$250 if you wish. While these are significant differences, the 1041 GT is a competent plotter in many respects.

The operator panel has 25 color-coded buttons, four LEDs, and a two-line by 20-character LCD display. Some of the buttons control up to four different functions, but the labels and use of color help make programming the 1041 GT reasonably straightforward. In addition to the normal configuration capabilities, you can override your software's pen mapping, scale, rotate, and mirror; set alignment for pre-printed forms or gridded media; optimize calibration for different drums to improve accuracy; and choose the language for the message displays (English, Japanese, French, Italian, and German are provided, but not Spanish). Four configurations can be stored in nonvolatile memory. While the panel appears more complex than some others, it is very easy to use.

The 1041 GT uses CalComp's proprietary graphics language. While it is not as widely supported as HPGL, most CAD software will drive CalComp plotters with no difficulty. Some ancillary software and many business graphics programs do not support CalComp's language, but a CPGL option (COST) is available that emulates HPGL. CalComp is very forthcoming

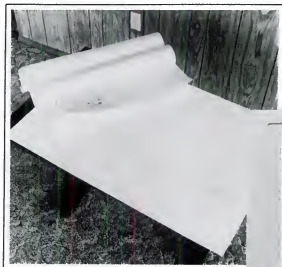
about the HPGL commands that their emulations don't support. We did not test the CPGL option, but a review of the commands indicated that most plots should present no problems. You can choose CPGL instead of CalComp's language at no cost when you order the 1041 GT; otherwise it costs \$500 thereafter.

The 1041 GT's eight-pen rotary carou-



The CalComp 1041 GT is the same size as most E-size plotters, yet it plots only up to D-size. This is because CalComp has based this plotter on the older, E-size 104x series. The operator panel (left) has 25 color-coded buttons, four LEDs, and a two-line by 20-character LCD display.

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■ PLOTTERS

sel travels with the pen head, which eliminates the need to return to a stationary stall or carousel to pick up pens. CalComp offers plastic- and fiber-tip, liquid ball, and disposable and refillable liquid-ink pens in a variety of colors. The plotter senses the type of pen used and adjusts itself accordingly.

The documentation also includes instructions for other models in the 1040 line. This is unnecessary and potentially confusing to the 1041 GT buyer. On a brighter note, CalComp provides extra sheets that explain how to interface the 1041 GT with several major microcomputer CAD programs. The various DIP switch settings and the supplied cable worked with AutoCAD with no problems.

Media insertion is very easy. The 1041 GT is a typical roller-bed plotter, and as with many such units, one of the pinch wheels moves to accommodate media from D-size down (given the extra width of the 1041 GT's plot bed, it's also perfectly happy with E-size media, for that matter, even though it won't plot larger than D-size). Vacuum hold-down ensures media flatness in the drawing area. The 1041 GT seeks the edges of the medium and determines medium size automatically.

Our sample 1041 GT was not equipped with the optional optimization system, and its effects were missed. Plot times were not particularly impressive, but plot quality was excellent. Diagonals in the nozzle plots were well-nigh perfect. However, the four-color shuttle plot took fully twice as long as the one-color version, which is

somewhat surprising given the 1041 GT's traveling-pen carousel design.

The 1041 GT is solidly constructed and beautifully engineered. Its front panel is elegant and functional, and our test plots were impressively accurate and attractive. We would order one with the optimization logic to increase plot speed, which brings its price within calling distance of some rather capable E-size plotters (and there are some fine D-size competitors available, too). Overall, though, if you need only D-size plots, the CalComp 1041 GT is a heavyweight contender.

HEWLETT-PACKARD CO.

HP Draftmaster I HP Draftmaster II

Hewlett-Packard Co. has dominated the plotter market for many years. It is as successful with its small desktop plotters as with its large CAD-oriented devices. Its 7585 and 7586 E-size plotters have enjoyed great success and are used on computers ranging from mighty mainframes to compact desktops.

With aggressive competitors nipping at its heels, HP has now introduced two new E-size plotters with advanced features at greatly reduced prices. The new HP Draftmasters live up to the HP plotter legacy—they perform beautifully, have several innovative design features, and reflect an attention to detail that has endeared HP equipment to a wide audience.

The Draftmaster is available in two models, the Draftmaster I to plot on sheet media and the Draftmaster II for both sheets and roll media. Like other HP plotters, the Draftmasters are roller-bed plotters that use two grit wheels and vacuum to anchor the media. One of the wheels is movable to allow plotting on media from A- to E-size. Not all large plotters can accommodate small media for check plots, documentation, or archiving, so this flexibility can be useful.

The Draftmaster's rotating eight-pen carousel (two are supplied with each plotter) accommodates five types of pens: paper, transparency, roller-ball, and disposable and refillable liquid-ink drafting pens. This is far more convenient than previous

HP arrangements, in which pens had to be used with specific carousels and couldn't be interchanged. Mechanical movements of the pen carousel elements inform the plotter of the type of pen loaded, and you can mix different pen types on the same plot. The pens are automatically capped when not in use and are returned to the carousel if not used for a while.

The operator panel features a 20-character by two-line LCD display. You can display messages in English, French, German, Spanish, Italian, or Japanese. The plotter is configured and operated through a tree-structured menu system, as are many high-end plotters in this class. The Draftmaster's menu system is well thought out and is simpler to understand and use than many.

The menu offers some unusual options. For example, you can align the plotting axes with gridded media, invert the plot orientation, emulate the older 7585 and 7586 if your software doesn't support the Draftmaster directly, and even plot more quietly if necessary (with some speed penalty, however).

Another snazzy and useful feature lets you group pens to minimize the ever-present risk of running out of ink during multiple plots or when your plot calls for a lot of solid area fill. You can assign two, four, or all eight pens to one group, and the Draftmaster will automatically switch to the next pen stall in your defined group after drawing 100 meters. A pen-sorting and area optimization routine is provided. You can even modify the plotter's operation for



FACT FILE

CalComp 1041 GT

CalComp
2411 W. La Palma Ave.
P.O. Box 3250
Anaheim, CA 92801
(800) CAL-COMP
(714) 821-2000

List Price: \$6,495; optimization buffer system, \$500; joystick, \$250.

In Short: It's slightly expensive for a plotter that does not accommodate E-size plots, but the 1041 GT is solidly constructed and creates good plot quality.

CIRCLE 648 (IN READER SERVICE CARD)



EDITOR'S CHOICE

FACT FILE

HP Draftmaster I

HP Draftmaster II
Hewlett-Packard Co.
16399 W. Bernardo Dr.
San Diego, CA 92127
(800) FOR-HPPC

List Price: Draftmaster I (sheet media only), \$9,900; Draftmaster II (sheet and roll media), \$11,900.

In Short: The newest HP plotter is selected as an Editor's Choice. Its new design is more sophisticated and allows for a cut in price without a loss in features and performance.

CIRCLE 644 (IN READER SERVICE CARD)

■ PLOTTERS

automatic operation with a modem for remote plotting.

In the long tradition of first-rate HP documentation, the Draftmaster's manual is superb. Copiously illustrated and clearly written, the documentation makes a complex device easy to install and use.

Both Draftmaster models sell for around 25 percent less than their 758x counterparts, which they replace. It's natural to wonder if anything has been sacrificed. HP claims that, if anything, it's the other way around. Its goal for the new models was to increase performance and reliability while reducing costs. The Draftmasters are totally redesigned and have

pen changes (it reduced our four-color shuttle plot time from 11 minutes and 17 seconds to 3 minutes and 22 seconds), but it doesn't perform geographical optimization and thus had no effect on our single-color nozzle drawings.

The Draftmasters are yet another in a long line of superior plotters from Hewlett-Packard. The Draftmaster II we tested was

first-rate in every respect. Certainly there are other outstanding E-size plotters in this exalted price range. The fact that the Draftmaster I is \$1,000 or so more than the fine Calcomp 1043 and \$2,000 more than the Zetadraf 900 reviewed in this issue might be worth some thought, but no one can argue with the marvelous performance of the newest HP products.

■ The Draftmasters are yet another in the long line of superior plotters from Hewlett-Packard. The Draftmaster II we tested was first-rate in every respect.

one-third the parts count of the older plotters. A patented new variable-reluctance motor provides high torque and full speed over any portion of the plot with very low heat buildup.

As they say, the proof of the pudding is in the eating, and our sample Draftmaster II proved tasty indeed. Media insertion and handling was easy and foolproof. Plot quality was superb with fiber, roller-ball, and disposable liquid-ink pens. The automatic medium feed of our Draftmaster II allowed continuous plotting and was also convenient for simply feeding the next portion of medium into position if individual plots were produced.

Plot speeds were very fast, and even adjusting pen speed above suggested values did not seem to have any effect on plot quality. The Draftmasters' Sort option proved to be highly effective in reducing the time required to plot images with many



The Editor's Choice nod for large-format plotters goes to Hewlett-Packard's Draftmaster series. The overall quality it provides is well worth the hefty price. The 18-button operator panel (left) features a two-line by 20-character LCD display.

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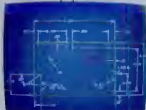
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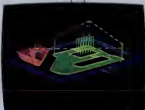


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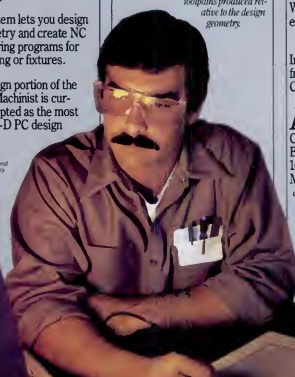
Personal Machinist



The screen display at left shows a top view of a 3-D model with dimensions. It was created using the design module. To the right is an isometric view of the toolpaths produced relative to the design geometry.



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■ PLOTTERS

***** IOLINE CORP.

Ioline LP4000

The Ioline LP4000 is a roller-bed plotter that can handle media from E-size down to as small as 1½ inches wide. It uses cut sheets only, although you can unspool a roll medium stored on a horizontal bar and cut it along a groove with a paper cutter supplied by Ioline Corp.

Perhaps the most significant change in the new model is the use of precision servo motors instead of the stepper motors used in Ioline's earlier model LP3700. There

temperature, variations in the density of the media to be plotted upon, even the media drive mechanism itself. Micro calibration can improve accuracy from the normal +/- .5 percent to as high as +/- .01 percent of overall plot size.

The 24-button, membrane operator panel is marked for many common functions, but there are many key combinations

that don't appear on the small buttons themselves. The only way to find the correct values to use or recall the sequences themselves is to refer to the manual. Perhaps Ioline could use the top surface of the plotter, immediately above the panel, for a card outlining all the commands available. Plotter status is indicated by 10 LEDs that aren't as powerful as the alphanumeric

■ While the LP4000 weighs a third of some of its competitors, all the key components are metal and the plotter will stand up to commercial use.

are several other improvements and conveniences too.

The older LP3700 didn't store any plotter settings you made via the front panel, an annoying deficiency that required you to enter new parameters every time you turned on the plotter. The LP4000 corrects this with programmable, nonvolatile memory that can store control parameters for three different users. You can program the plotter with the operator panel or with a simple utility provided by Ioline on disk; your choices can be saved to disk for future reference, too.

The LP4000's range of adjustable parameters is extensive. The standard adjustments like pen force, up and down delays, and velocity and acceleration are available, and you can also remap pen selection to override software pen choice instructions and more. With the optional \$795 HyperBuffer installed, you can enable pen sorting and localization optimization. In addition, an interesting micro calibration feature allows compensating for humidity,



The slim Ioline LP4000 weighs much less than most of the competition, but it doesn't skimp on quality. Plot times are slower than HP's Draftmaster, but the LP4000's lower price more than compensates. The operator panel (left) is membrane style.

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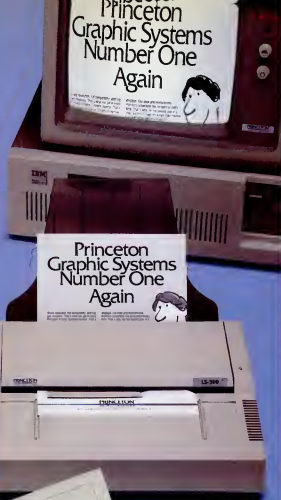
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■ PLOTTERS



FACT FILE

Ioline LP4000

Ioline Corp.
19417 36th Ave. West, Suite D1
Lynnwood, WA 98036
(206) 775-7861

List Price: \$5,495; HyperBuffer, \$795;
eight-pen changer, \$500; each additional
four-pen tray, \$100.

In Short: Though slower than some of its
competitors, the Ioline LP4000 offers excel-
lent plot quality and a low price tag.

CIRCLE 643 ON READER SERVICE CARD

readouts of some large-size plotters but
work quite well.

Installing the LP4000 via its serial inter-
face is easy. The Ioline installation disk in-
cludes an effective program to check and
debug the interface if necessary.

The LP4000 is basically a single-pen
plotter. An optional multipen changer can
store up to 20 pens in five trays holding 4
pens each. Each pen is capped with a soft
plate that seems to work as well as the us-
ual rubber grommet. The long bar that holds
the trays can be stored out of the way on
the top of the plotter. The pen changer can
hold standard HP pens, which provides
tremendous flexibility in pen selection.
The pen changer costs \$500 in an 8-pen
configuration, and each additional 4-pen
tray adds another \$100.

The LP4000 does not use the common
Hewlett-Packard Graphics Language, opt-
ing instead for Houston Instrument's
DM/PL language. While DM/PL is not as
popular as HPGL, most CAD packages do
support it, but you should be sure that your
software package is compatible with
DM/PL.

PC Magazine has reported mixed re-
sults with Ioline's previous model LP3700
or its OEM'd equivalent marketed by other
companies. Our biggest concern was the
mediocre diagonals and overall lack of pen
control, combined with less than lightning
speed. The LP4000 isn't a speed demon ei-
ther, but the quality of the plots has been
totally transformed.

The impact of the change from stepper
motor to servo is tremendous. The LP4000
now produces clean diagonals and high-
quality plots overall. Plot times were not-

ing to write home about, though. The pen-
changing mechanism worked perfectly
through the large number of pen changes
in our four-color shuttle plot, but it's very
slow. The four-color plot took over three
times as long as a single color plot of the
same image. Remember that these plots
were created with neither AutoCAD's opti-
mization routines enabled nor Ioline's own
optional HyperBuffer installed. Using ei-
ther technique would have minimized the
pen changes and reduced the plot time sig-
nificantly.

Construction quality is good but not
lavish. While the LP4000 weighs a third of
some competitors, all the key components
are metal and the plotter will stand up to
commercial use. The LP4000 doesn't have
the "flash" of some of its competitors, but
there are those who might consider that a
virtue. Our test LP4000 was supplied with
the LP3700's documentation and a set of
addendum pages. The LP4000's manual
will be available later. Hopefully it will be
less terse and more helpful.

Overall, the Ioline LP4000 is a much
better plotter than its predecessor and
generates impressive high-quality images.
The Ioline's price is reasonable, although
similarly priced plotters from HP, HI, and
CalComp are stiff competition. It's defi-
nitely competitive now, though, and the
trade-off between somewhat slower plot-
ting, plot quality, and cost tips the scales in
the new Ioline's favor.

ROLAND DG

Roland DXY-885 Roland DXY-990

The Roland DXY-885 and DXY-990 are
eight-pen, flatbed, B-size plotters. We
have included them as examples of innova-
tion in the desktop market. Their plot-
ting mechanisms are identical, but they
differ in media feeding and operator pan-
els. Both can operate horizontally, flat on a
table top, or in an almost vertical position.

Serial and parallel interfaces are stan-
dard on both plotters. Two DIP switches
with 18 individual switches are used to
configure the interface and set other op-
erating defaults. A rotary control adjusts the
force at which the pen is pressed down



FACT FILE

Roland DXY-885

Roland DXY-990
Roland DG
7200 Dominion Circle
Los Angeles, CA 90040
(213) 685-5141

List Price: DXY-885, \$1,695; DXY-990
(with electrostatic paper hold), \$2,295.

In Short: Roland DG's two desktop-sized
plotters are superior to their predecessors and
offer high-quality output.

CIRCLE 644 ON READER SERVICE CARD

against the media. Since the force that is
needed varies with the pen type, this con-
trol is useful.

Both plotters emulate the Hewlett-
Packard HPGL graphics language that has
become almost a de facto standard
throughout the plotter industry. The HPGL
emulation is a major advance over some of
Roland DG's older designs, which used a
proprietary graphics language. Since nearly
all graphics programs support HPGL,
the Roland plotters are compatible with a
wide variety of software.

The DXY-885's operator panel is a
simple membrane design with four arrow
"buttons" to move the pens, a fast-speed
control to move them faster, P1 and P2
buttons to set plot size, and so on. Some
special commands are invoked by holding
down combinations of the buttons, which
works well but would be easier if there
were markings for the special combina-
tions. Overall, the DXY-885's panel is
nothing fancy, but it's adequate for most
situations.

The DXY-990's operator panel also
uses a membrane covering, but it adds sev-
eral more controls, for example, buttons to
select individual pens or move the pen
head to the upper-right or lower-left home
positions. The most noticeable enhance-
ment are two four-digit displays that show
the current x- and y-coordinates of the pen
head in millimeters. While this display can
be useful if you're using the plotter as a
digitizer or for debugging, for the most
part it's a frill.

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row along the left edge of the plot bed. The
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■ PLOTTERS

stalls to prevent drying out. A mechanical soft-landing mechanism gently lowers the pens to the media. If a pen is down on the media for a certain period, it is lifted from the surface automatically to prevent smearing. Pen insertion is easy and positive. Roland offers an extensive assortment of water- and oil-based fiber, ceramic tip, water-based ballpoint, and liquid-ink pens. Standard HP pens will fit as well, so pen flexibility is excellent.

The DXY-885 and DXY-990 use different methods to hold the media in place. The plot bed of the DXY-885 is magnetized metal, and four thin metal strips are

supplied to hold the medium down. The ends of each strip are bent to make them easier to remove. As with any magnetized bed, putting a floppy disk on the bed will almost assuredly result in lost data. It's not always easy to get the medium perfectly flat with this hold-down method. If it isn't, your plot can be ruined as a pen grazes along a raised area on the medium. The DXY-885's simple hold-down system did work better than many similar designs, though, and we did not experience any ruined plots during the tests.

The DXY-990 uses electrostatic hold-down. In this system, a static charge is ap-

plied to the surface of the plotbed, causing the medium to cling to the bed. This is a superior method because there are no strips to lose or for the pen carriage to bump into if they're not positioned correctly, and



EDITOR'S
CHOICE

• HP Draftmaster series

PC Magazine was impressed with all the new plotters tested this time around. Plot quality and accuracy were fine across the board, and all included amenities that made the plotting function more convenient.

Two plotters stood out as exceptional, though. The \$9,900 HP Draftmaster I and the \$7,950 Bruning Zetadraf 900 are completely new designs from companies that are long respected in the large plotter category. Both are laden with features and have advanced engineering.

Designating Hewlett-Packard plotters as Editor's Choices is becoming something of a habit. We've chosen their desktop and D-size plotters in past reviews, and the HP Draftmaster also richly deserves our kudos. Plotters in the Draftmaster series cost thousands of dollars less than the well-regarded HP models they replace, and the cost reductions appear to have been achieved with elegant engineering, without any loss in performance or quality of construction.

Honorable mention goes to the Zetadraf 900. Fully \$1,000 to \$2,000 less than its major competition, it's an exceptional value. Its stunning styling and solid construction are a joy to behold. It just missed becoming an Editor's Choice, though, because its plot quality in the early production model tested fell short of the other large plotters evaluated here. When Bruning irons out a few details, the Zetadraf 900 could well rise to the top of the price/performance heap.

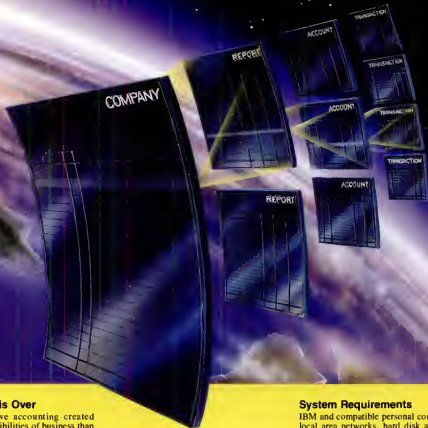


Roland's DXY-885 (left) and DXY-990 (right) are among the brightest new stars in the desktop plotter market. They are included in this review because of their recent arrival

on the scene. The DXY-990 is the more sophisticated of the two; it holds media in place with the fast and convenient electrostatic hold-down method.

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■ PLOTTERS

electrostatic hold is much faster and more convenient. As with all such designs, you still have to be careful to smooth the medium by hand lest air bubbles get trapped underneath, but overall the DXY-990's hold-down worked well.

We tested both plotters in the horizontal position, which we found the more convenient way, since positioning and holding down the medium was easier. The water-based pens and sample paper supplied by Roland were used throughout our evaluation. We could not use the parallel interface, since AutoCAD recognizes only seri-

■ Plot times for both Roland models were essentially identical and were on the slow side compared with larger and more costly plotters.

al connections for the HP 7475 plotter, which the Roland emulates. The documentation's suggested switch settings for the serial interface at its highest rated speed of 9,600 bits per second worked perfectly with the AutoCAD software.

Plot times for both models were essentially identical and were on the slow side compared with larger and more costly plotters. Line quality was good, and diagonals in the nozzle were excellent. The unoptimized shuttle drawing does a tremendous amount of pen changing, and the rather leisurely pen change speed on both units slowed the plots considerably.

Both the DXY-885 and DXY-990 are quality plotters that are superior to their ancestors in the Roland line. Their construction is more than adequate, plot quality is fine, and their price is reasonable vis-à-vis their competition.

Glenn Hart is a contributing editor of PC Magazine.

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WINDOWS SHOPPING:

anybody who thinks that the micro-computer industry moves too quickly should examine the history of *Microsoft Windows*.

Windows is a graphics-based operating environment for the IBM PC that simultaneously runs several applications in windowed areas on the display. Programs written for *Windows* can incorporate a standardized user interface, use device-independent display and printer graphics, and pass data among themselves.

Microsoft started work on *Windows* early in 1983. It announced the product in November of that year and set a May 1984 shipment date. Over the next year and a half, *Windows* had many shipment dates. When *Microsoft Windows* was finally released in November 1985, Microsoft top

brass predicted the program would be a "slow burn." Obviously everybody was a little weary of overly optimistic predictions.

At that time, *Windows* was one of several operating environments that had recently become available for the IBM PC. In a cover story that proclaimed "Window Wars!: Operating in a New Environment," *PC Magazine*, Volume 5 Number 4), *Microsoft Windows* faced off against its competitors—IBM's *TopView*, Quarterdeck's *DESQview*, and Digital Research's *GEM Desktop*.

Since then, it has become increasingly obvious that the war is over and *Windows* has won. Although it may take a year or two more to prove them correct, many industry observers feel that *Microsoft Windows* is well on the way to becoming the

APPLICATIONS for the ENVIRONMENT

Now the fun begins. Software developers have finally started to tap the power of Microsoft Windows with programs designed to be used exclusively within its unique operating environment.

■ WINDOWS APPLICATIONS

predominant operating environment for the IBM PC.

THE OPPOSING VIEW Of course, not everyone agrees. Some people refer to the program as "Broken Windows" or "Microsoft Widows." Others refuse on general principle to use a PC program that uses a mouse or otherwise reminds them of the Apple Macintosh.

Nor does *Windows* have a good reputation among users who have purchased and installed the program. You've heard the complaints: *Windows* is slow. *Windows* takes up too much hard disk space. *Windows* is a memory hog. *Windows* doesn't allow many existing RAM-resident programs to work under it. *Windows* can't adequately run existing applications.

For a \$99 package, *Windows* comes with an impressive array of applications (a word processor, a monochrome painting program, a communications program, a notepad, calculator, calendar, clock, and print spooler), but none of them come anywhere close to the functionality of popular programs written for the normal MS-DOS environment. Although *Windows* can run existing MS-DOS programs, it doesn't do so very well.

Thus for many users, *Windows* ends up as "shelfware"—the program that almost everybody owns but nobody uses.

Does this contradict the industry experts who see *Windows* as the future of the PC? Not at all.

SO WHAT IF IT'S SHELFWARE? If *Windows* were an applications program, its shelfware status would indicate a serious problem. But *Windows* is not an applications program. *Windows* is an operating environment, and operating environments (like operating systems) are important only to run programs that require them.

After all, why do people have MS-DOS on their systems? What is MS-DOS good for and what can you do with it? Well, you can create and edit files with EDLIN, you can make some subdirectories, copy the files around to other directories, get a list of them, delete a few, and then run CHKDSK to see how much disk space you have left. Great fun, huh? Real productive, right?

People run MS-DOS only because they



FACT FILE

Microsoft Windows, Version 1.03

Microsoft Corp.
16011 NE 36th Way
Box 97017
Redmond, WA 98073
(800) 426-9400
(206) 882-8080

List Price: \$99

Requires: 320K RAM (640K recommended), two disk drives (hard disk recommended), graphics board and display, optional mouse, DOS 2.0 or later.

In Short: The *Windows* operating environment comes with several applications (word processing, monochrome painting, and communications programs: a notepad, calculator, calendar, clock, and print spooler) and can run most existing DOS applications. However, the primary purpose of *Windows* is to run programs specifically designed for its environment. Not copy protected.

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Microsoft Windows Software Development Kit 1.03

Microsoft Corp.
16011 NE 36th Way
Box 97017
Redmond, WA 98073
(800) 426-9400
(206) 882-8080

List Price: \$500

Requires: 512K RAM, *Microsoft Windows*, *Microsoft C Compiler 4.00* (or other *Windows*-compatible C Compiler), *Macro Assembler* or *Pascal Compiler 3.31*, hard disk.

In Short: The three manuals and seven diskettes that are included with the *Windows* Software Development Kit let programmers design applications for the *Windows* environment. Warning: it's not easy. Not copy protected.

CIRCLE 900 ON READER SERVICE CARD

need it to run their favorite applications programs. MS-DOS would be irrelevant if these applications programs didn't exist.

Although *Windows* can run most existing DOS applications, that's not what it was made for. *Windows* exists primarily to run programs specifically written for the *Windows* environment. These programs take advantage of the *Windows* user interface, its hardware device drivers, the *Windows* clipboard, and graphics.

It doesn't really matter how many

copies of *Windows* are sold and how many end up unused on people's bookshelves. The success of *Windows* ultimately rests with the software developers. If programmers develop hot applications for *Windows*, then *Windows* will become the standard operating environment for the PC. If the software developers ignore *Windows*, then *Windows* will be a failure, regardless of how many copies are sold.

Microsoft realizes this more than anybody. They make available a *Microsoft Windows Software Development Kit* that includes three big manuals and seven diskettes with development tools and sample programs. They organize *Windows* development seminars, *Windows* training courses, and a *Windows* developer's bulletin board on the GENIE (the General Electric Network for Information Exchange) information service. Microsoft even allows software manufacturers to deliver a working version of *Windows* with their *Windows* products.

When Microsoft pitches *Windows* to software developers, it uses the slogan "The future starts here." Increasingly, the software developers are agreeing.

PROGRAMS FOR WINDOWS In the pages that follow, you'll read reviews of eight *Windows* programs. These programs were written specifically for *Windows* and require *Windows* to run. They are the first generation of a wide range of programs that will bring *Windows* to the desks of nearly all PC users.

For readers who are wondering why *PC Magazine* is not running a similar roundup of programs developed for competing operating environments such as Digital Research's *GEM Desktop* or IBM's *TopView*, the answer is simple: the products don't exist, and these operating environments have no real future.

At present, at least three notable programs are being developed to run under *Windows*. One heavyweight program reviewed earlier this year and not covered again here is *PageMaker* from Aldus Corp. (See "Muscling In on the Mac: PC-Based Page Composition," *PC Magazine* Volume 6 Number 3). *PageMaker* was originally developed for the Apple Macintosh and virtually defined the concept of desktop publishing on small computers.

Microsoft's *Excel*—the very popular spreadsheet program also originally developed for the Apple Macintosh—is now being ported to *Windows* and is expected to be released later this year. Just as *Excel* for the Macintosh has sold lots of Macs, *Excel* for the PC is expected to sell *Windows*.

Micrografx, the developers of *In*ra*Vision* and *Windows Draw* has a third *Windows* program currently being readied for release that does business graphics.

Who else is developing programs for *Windows*? Many major software manufacturers have publicly stated their support of *Windows* while keeping quiet about future products. But think about spreadsheets, database managers, word processors, and micro-to-mainframe communications and you get a good idea of the major companies doing something with *Windows*. Possibly by the end of this year and definitely by the end of 1988, you should be able to spend most of your PC time in *Windows* using *Windows* applications that are as good as or better than existing programs for the DOS environment.

Users who haven't yet looked at *Microsoft Windows* needn't worry about falling behind. They will find themselves running *Windows* the minute they start using a program, such as *PageMaker* or *Excel*, that runs under *Windows*.

On the other hand, program developers—professional or otherwise—who haven't yet taken a close look at *Microsoft Windows* are simply being negligent. Let's look at DOS and *Microsoft Windows* to see what *Windows* has to offer.

THE PROBLEMS WITH DOS *Windows* is an operating environment that runs under DOS and functions as an extension of DOS. MS-DOS, as the name implies, is almost exclusively a disk operating system and does little more than manage files and load programs.

DOS has many failings. Its memory management is crude, and despite a few undocumented "hooks" for memory-resident programs and multitasking, it can really run only one program at a time. In addition, MS-DOS provides almost no support for the video display, the printer, and the RS-232 serial port.

But fast interaction with the video display is a characteristic of programs devel-

oped for small computers. Almost immediately after the PC became available in 1981, program developers realized that the DOS and BIOS services for the video display were simply inadequate. For performance reasons, applications programs were forced to circumvent the operating system and go directly to the hardware.

COMPATIBILITY GRIDLOCK This has created a problem I call "compatibility gridlock." Because of the current inadequacies of the DOS and BIOS hardware interfaces, PC programs are forced to include system-level code. Because PC programs include system-level code, hardware must be cloned. Hardware manufacturers can't be innovative because some existing software won't work on hardware that is less than 100 percent compatible.

The IBM Enhanced Graphics Adapter is the best example of this. Some software manufacturers took years to upgrade their products to use the EGA. When other manufacturers began developing EGAs, they had to duplicate all the bugs and quirks in IBM's hardware and BIOS so that the existing programs would work right.

Software manufacturers must face the problem of adapting their programs to run on a wide variety of graphics boards. The only three graphics boards to achieve widespread support are the IBM Color/Graphics Adapter, the IBM Enhanced Graphics Adapter, and the Hercules Graphics Board. But we are on the verge of seeing high-resolution video boards based on the Texas Instruments 34010 and Intel 82786 graphics coprocessors. These boards will differ so much from the CGA and the EGA that support from each individual software manufacturer is almost inconceivable.

DEVICE INDEPENDENT With *Windows*, things have changed. *Windows* includes a device-independent interface to the display, keyboard, mouse, printer, and RS-232 serial port through driver modules. Programs written for *Windows* do not directly access the hardware: programs use the drivers, and the drivers access the hardware. Programs written for *Windows* use DOS only for file I/O.

This has benefits for everybody. The

software manufacturer of a *Windows* application doesn't have the burden of writing system-level code to support a huge number of displays and printers. If the device has a *Windows* driver, the *Windows* program will work with it.

Hardware manufacturers are also freed from the burden of convincing software vendors to support their hardware. With a single *Windows* driver, the hardware becomes accessible to all existing and future *Windows* applications (see "Four-Figure Video," *PC Magazine*, Volume 6 Number 10). In that story, several *Windows* applications (including a *PC Magazine* benchmark test program) are shown running on high-resolution video boards. The authors of those programs did not have to include anything special in the code to run on these boards: if the program runs under *Windows*, it runs with any hardware that has a *Windows* driver.

CONSISTENT USER INTERFACE

As everyone knows, programs written for the PC today use a variety of different command strategies including command lines, function keys, Ctrl keys, Alt keys, and menus. Think about the different methods you must use to save a file in different programs. Consider the time it takes to learn how to use a new program and get accustomed to it.

Programs written for *Windows* have a similar look and feel and use a common command interface: A caption bar across the top of the window indicates the program name and the currently loaded file. A system menu box at the left of the caption bar allows you to move, resize, zoom, icon, or close an application.

Below the caption bar is a menu bar. You can select menu items either by using the mouse or by pressing the Alt key and the first letter of the menu item. Some menu items invoke dialog boxes. Dialog boxes are pop-up windows that contain buttons, check boxes, edit fields, and boxes with lists of items in them. The methods for moving around the dialog box and making selections are the same for all *Windows* programs.

Because software manufacturers use the built-in *Windows* user interface, they needn't write their own. They are freed from describing how to use menus and dia-

■ WINDOWS APPLICATIONS

log boxes in their manuals because this information is adequately described in the *Windows* manuals.

The consistent user interface makes programs much easier to learn. Once you know how to use one or two *Windows* programs, you basically know how to use them all.

NO-HASSLE GRAPHICS *Windows* is a graphics-based operating environment and requires a graphics video board and display to operate. The use of graphics is the primary cause of *Windows*' speed problems in comparison with text mode windowing environments such as IBM's *TopView* or Quarterdeck's *DESQview*. Graphics involves much more data than a text mode display and currently is much slower. (The introduction of video boards based on graphics coprocessors will help lessen this speed differential.)

People who laugh in derision at Macin-

tosh programs with their pictures of scissors, paste jars, and trash cans will find most *Windows* applications to be relatively free of silly icons. What graphics does in *Windows* is release programmers from the tyranny of text-mode video. Text-mode video is really just a very limited subset of graphics mode, so programmers can use simple text as well as graphics for a higher density of display information.

A *Windows* word processing program (such as *Windows Write*) can use true WYSIWYG and show on-screen formatting with multiple fonts. A *Windows* database program can store bit-mapped data as easily as it can handle text. A *Windows* communications program (such as *Windows Terminal*) can use a smaller font to show more data on the screen.

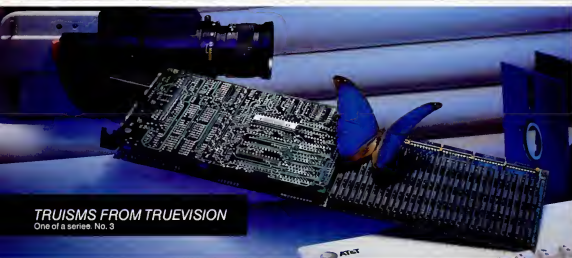
Everything looks a little prettier in graphics mode. Rectangles can have rounded corners; circles and ellipses become possible; items can be precisely

placed anywhere on the display and not just on character boundaries. In graphics mode the mouse and scroll bars work more smoothly and glide across the display rather than jumping between character positions.

PROGRAM JUGGLING MS-DOS is not a multitasking operating system. While there have been many attempts to put a shell around MS-DOS that allows multitasking between existing programs (in fact, *Windows* itself can do this), the results have never been satisfactory.

Windows does multitasking. It can display and run several *Windows* applications in tiled areas on the screen. The user can easily switch between programs, expand any program to use the full screen, or put a program to sleep by turning it into an icon.

Windows incorporates an unusual "nonpreemptive scheduler" for multitasking. In one sense, *Windows* programs vol-



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untarily allow themselves to be multitasked, and *Windows* never preemptively interrupts one program so that another can run. This eliminates many of the problems involved with putting a multitasking shell on top of a single-tasking DOS.

When the operating system is capable of multitasking (as it will be when the version of DOS becomes available that runs under the protected mode of the 80286 microprocessor), then *Windows* will include a preemptive multitasking scheduler.

MEMORY MANAGEMENT Once an operating environment such as *Windows* takes on the responsibility of running several different applications at once, it is also faced with problems of memory management. If several programs are loaded into memory and then several of them are terminated, the operating environment must be able to consolidate the free memory to make space for other programs.

Here is where *Windows* shines. *Windows* incorporates a memory management scheme that implements in software many of the memory management features from the forthcoming version of DOS that uses the protected mode of the IBM PC AT's 80286 microprocessor. *Windows* does protected-mode memory management in a real-mode environment.

Most programs written for *Windows* can be moved around in memory. From a programmer's perspective, this is quite an amazing feat. *Windows* also includes a concept of "read-only data." Any read-only data originally loaded from a disk file and stored in memory can be discarded by *Windows* to make space. This includes bit maps for icons and cursors, templates for menus and dialog boxes, and even program code itself. *Windows* keeps track of where the data originally came from and retains enough information to reload it from disk when necessary.

SHARING DATA PC users have always been faced with problems of transferring data from one program (such as a spreadsheet) into another program (such as a word processor). It can usually be done, but it's never simple.

Windows lets programs exchange data through a mechanism called the "clipboard." (The CLIPBRD program that comes with *Windows* is not the clipboard itself but rather a "clipboard viewer"—it shows you what is in the clipboard.)

Transferring data from one *Windows* program to another involves the same steps regardless of the programs: In the first program, block out the data you want to transfer. Select Edit Copy from the menu or press the F2 key. That transfers the data to the clipboard. Go to the second program and select Edit Paste from the menu or press the Insert key. That transfers from the clipboard into the program.

When working with Aldus's *Page-*



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September 30, 1986



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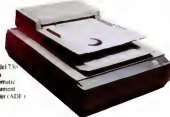


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■ WINDOWS APPLICATIONS

Maker, for instance, you can copy text from *Windows Write*, a bit-mapped picture from *Windows Paint*, and a "metafile" (which is a collection of drawing commands) from Micrografx's *Windows Draw*. Any future word processor or drawing program for *Windows* will also be able to provide text or pictures for *PageMaker*.

DYNAMIC DATA EXCHANGE While the clipboard is certainly convenient for "manual" transfers of data from one application to another, the Dynamic Data Exchange (DDE) protocol automates inter-process data transfers.

Windows is a messaging system: it normally sends messages to applications to inform them of system events, but it also lets applications send messages to one another. One application can inform another that it has some data the second application may find useful. It can then pass this data in the form of a "handle" (a 16-bit number) that references a block of memory.

The most common example of a DDE application is this: The "server" application is a program that can receive stock quotations, either through an electronic link over the telephone or over the airwaves. The "client" application is a graphing program that processes stock quotations. After the server and client applications establish a DDE link, the server receives stock quotations and sends them to the client. The client program then shows the changing prices of the stocks through its graphs.

Windows applications that use DDE indicate the type of data they can provide or accept through text strings (such as "Stock Quotes") sent out as messages to all currently running *Windows* programs. It is expected that software developers will publicize the DDE hooks in their programs so that other software programs can communicate with them through DDE.

THE FUTURE A common adage in the computer world is "hardware precedes software." *Windows* does not fit this simple formula. *Windows* is an operating environment that will accommodate the hardware of the future.

If you run *Windows* on a two-disk PC with a Color/Graphics Adapter, it's dreadfully slow and ugly. When you run *Win-*

dows on an IBM PC-AT with an Enhanced Graphics Adapter, you see a dramatic improvement in performance and a very pretty display. As processor speed increases and high-resolution video boards using graphics coprocessors become available, *Windows*—and existing *Windows* programs—will be ready to move up.

The real boost to *Windows* will come when a version is available that runs under the forthcoming protected-mode version of DOS. Because *Windows* uses many memory management features of protected mode, existing *Windows* programs are best for protected-mode conversions. Most will need only to be recompiled for the new DOS.—Charles Petzold

Actor

One surprising thing you can do with *Microsoft Windows* is program in an interactive, graphical, object-oriented language. Logo and Smalltalk are examples of such languages, and Actor is another.

Actor most closely resembles Smalltalk, the language and interactive programming environment developed at Xerox's Palo Alto Research Center. Smalltalk is a precursor of user interfaces such as *Macintosh Finder*, *GEM*, and *Windows*, and so implementing Actor under *Windows* closes the circle, so to speak. The question is, why would you want to program in Actor?

The biggest benefit is that you get to write useful programs under *Windows*, a

far less-painful solution than programming in C or assembler. The secondary benefit is that you learn about object-oriented languages. They're not for everybody, but object-oriented languages can be incredibly liberating. The main difference from conventional programming languages is that in most languages data is passive and instructions are active. Some instructions work only on certain types of data.

In Actor the instructions and data are joined together to make objects. These objects learn the characteristics of things that are being assigned to them on the fly. You stop thinking about even seemingly elemental things like the number 3 or the letter A as data. They're objects, too. They differ in their class, however. One is an integer and the other is a string. As you become familiar with Actor, it becomes a logically organized domain of objects, methods, classes, and subclasses.

So much for the joys of object orientation. On a more pragmatic level, you get control over the *Windows* environment. A simple task such as printing "Hello" in a window normally takes pages of code. *Windows* is based on a large collection of input/output routines that communicate with programs and one another through messages. Actor converts these messages to objects and vice versa. And a window, not surprisingly, is just another object to Actor. Thus you can create input and output windows, even to the point of editing text in them, and pass all the data back and forth to your Actor programs. The windows behave just as other windows do, with tiling, menu bars, scroll bars, and buttons. The bad news is that you need *Microsoft's Windows Toolkit* to learn about all of *Windows*'s messages. Also, Actor doesn't check to make sure your *Windows* calls are legal. Pass it the wrong parameters, and you blow your system away.

Actor contains two powerful tools that help you during the learning phase and in program development. If, for example, you had defined an object as an array and wanted to examine the values, the Inspector lets you look inside any object to see its contents. Inspector can also modify an object's contents. You can even inspect the objects that make up Actor since it is largely programmed in Actor. The Browser looks at classes and methods instead of ob-

**FACT FILE**

**Actor**
The Whitewater Group
506 University Pl.
Evanston, IL 60201
(312) 499-2370
List Price: \$495
Requires: 640K RAM,
Microsoft Windows.

In Short: Actor is an object-oriented programming language designed to run under *Windows*. It offers a programming alternative to C and assembly language and is especially suited to artificial intelligence applications. Not copy protected.

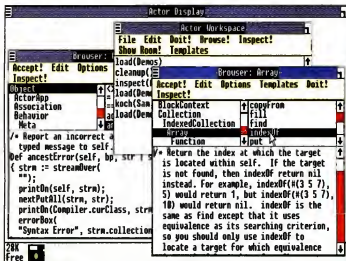
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■ WINDOWS APPLICATIONS

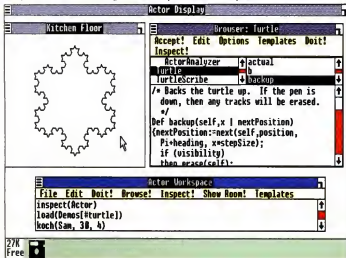
jects and is a great aid in learning how Actor works and how to program in it. You just browse Actor's source files and libraries for a tour-de-force education in object-oriented programming.

System performance on AT-class machines is pretty good and is in keeping with Windows' performance. Actor compiles each line of code as you write it, so you never see the overhead of compilation, and

■ Actor compiles each line of code as you write it, so you never see the overhead of compilation, and it's impervious to the potential slowness of an interpreter.



Actor uses a tiled window for general output and pop-up windows for all other interaction and modification services, including Browsers, Inspectors, and Workspaces.



Multiple windows are very handy when developing programs. The "Kitchen Floor" is an application window where a "Turtle" has drawn a figure.

it's impervious to the potential slowness of an interpreter. Object-oriented languages are a natural for artificial intelligence applications, and Actor is no exception. The documentation includes a good tutorial and introduces you to the concepts gently and with consideration. But it assumes, as does most documentation written by True Believers, that the light bulb will come on and that your brain will explode with the possibilities. Thus it points you down a number of paths and leaves the rest to your imagination. I'd prefer to see one or two of these ideas fleshed out, with examples, for the more thickheaded among us.

Actor won't be to everyone's liking. The contingent (im)patiently waiting for Windows BASIC will hate the syntax and having to unlearn all their bad programming habits. Smalltalk fiends will complain that Actor's notational syntax follows that of C rather than that of Smalltalk. Devotees of Logo will note that Actor is open-ended and has too many ways to crash the system for it to be much use as a teaching language.

You should understand that this review does Actor a disservice. If you've read this far and are still interested, you already know that. But it's more important that you know that Actor exists and that it is indeed powerful. If you think Actor will solve problems for you, the time spent exploring this unique and fascinating Windows application from the Whitewater Group will be more valuable than reading about it here. —Bill Machrone and William G. Wong

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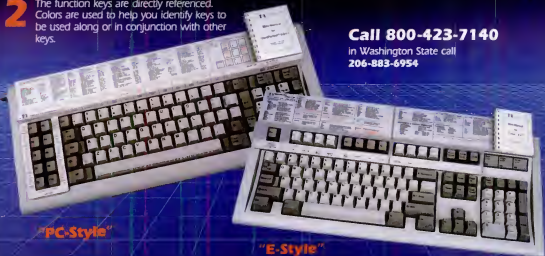
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■ WINDOWS APPLICATIONS

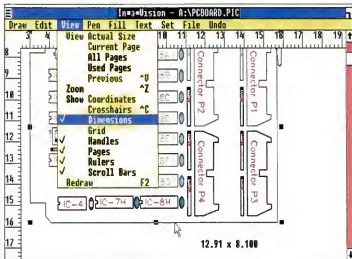
In**a**Vision

*In**a**Vision*, a CAD program from Micrografx of Richardson, Texas, had the distinction of being the first product designed for the *Microsoft Windows* operating environment. In fact, *In**a**Vision* was actually released before *Windows*. From the beginning, it was shipped with a special *Windows* run-time module that gives you the ability to run *In**a**Vision* outside of the *Windows* operating environment.

Other programs have since appeared for the *Windows* environment, but *In**a**Vision* is probably still the best *Windows*-specific application. While taking full advantage of the *Windows* environment and its ease of use, *In**a**Vision* provides an array of precise drawing tools for the design professional.

At first glance, *In**a**Vision* resembles other object-oriented drawing packages such as *MacDraw*, *GEM Draw*, and *In**a**Vision*'s younger, less-robust sibling, *Windows Draw*. Like the other products mentioned, *In**a**Vision* works within a bit-mapped operating environment that provides it with features like drop-down menus, vertical and horizontal scroll bars, an arrow-shaped pointer, and so on. In *In**a**Vision*'s case, of course, that environment is *Microsoft Windows*.

Aside from the operating environment, all these object-oriented drawing packages share some general features. Any product in this category draws objects using a combination of freehand drawing and a variety of predefined shapes. In *In**a**Vision*'s



*In**a**Vision*'s powerful View command allows you to change the dimensions of your drawing, shift the coordinates, and turn the cursor into a cross-hairs pointer for more precise placement during small-scale drawing.

case, these include circles, ellipses, squares, rectangles, rounded rectangles, jointed lines, horizontal or vertical lines, closed polygons, arcs, and pies with a variable number of pie slices.

The difference between an object-oriented drawing package and a paint package such as *Windows Paint* or *MacPaint* is the way the program treats the objects you have created. In a paint package, whatever you create is simply treated as a portion of your screen's bit-map pattern, and aside from filling it in, there's not much you can do with a shape once it has been created. An object-oriented drawing package, on the other hand, allows you to copy shapes, move them, change their color and fill pattern, make them larger or smaller, put them on top of or below other objects, and combine them with other objects to form a single, more complex object. In other words, it provides you with editing capabilities as far advanced over those of a paint package as those of a good word-processor are over EDLIN.

In any case, once you put these obvious similarities between all object-oriented drawing packages aside, it is clear that *In**a**Vision* actually should be compared

not with the low-end drawing packages but with professional design tools such as *AutoCAD*.

One thing that distinguishes *In**a**Vision* is its capacity. *In**a**Vision* can create drawings as large as 4,624 square inches (68 by 68 inches). In comparison, *Windows Draw* can create drawings only 1,156 square inches in size.

More important is the array of tools that *In**a**Vision* supplies to give you greater control over your work: Like most drawing packages, *In**a**Vision* gives you the choice of showing or hiding the grid on which you are drawing. You can also show or hide the rulers that run along the side and top of the screen and indicate the size of the page you're drawing on.

CROSS-HAIRS OPTION It also provides several other interesting options. For instance, you can change the default arrow-shaped pointer to a cross-hairs shape whose intersection defines exactly where the pointer is located. This can be very useful when you're trying to align objects within a drawing. Or you can use the View command to specify that you want a constant display next to the pointer (or cross-



FACT FILE



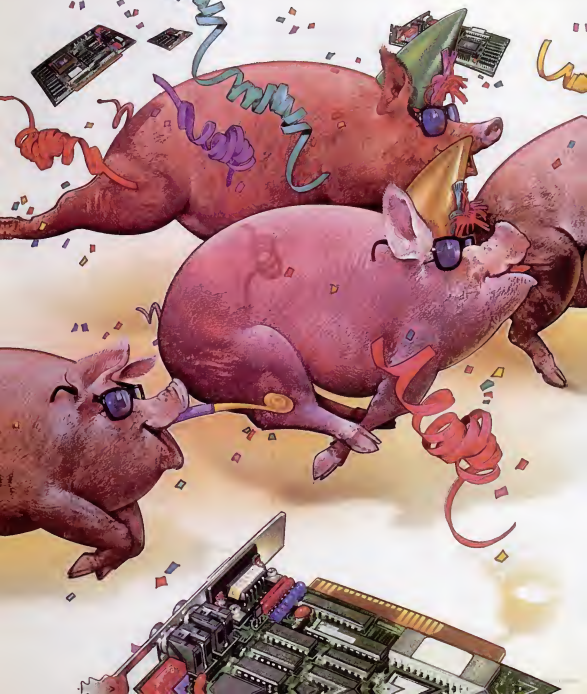
Ina**Vision**
Micrografx, Inc.
1820 N. Greenville Ave.
Richardson, TX 75081
(800) 272-3729
List Price: \$495
Requires: 320K RAM,
two disk drives or a hard

disk, graphics board, DOS 2.0 or later.

In Short: *In**a**Vision* is a precision drawing tool for users of CAD software. Not copy protected.

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■ WINDOWS APPLICATIONS

hairs) of the pointer's screen coordinates.

The coordinates are derived from an imaginary 32,767 by 32,767 grid whose origin point of 0,0 is the upper-left-hand corner of the drawing. There are 480 coordinate points per inch.

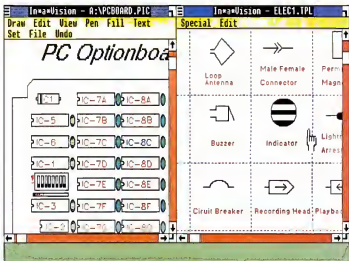
Alternatively, by selecting Show Dimensions on the View menu you can tell *In**a**Vision* to always display the dimensions of the currently selected object. (An object must be selected by "clicking" on it before it can be moved, sized, or otherwise edited.) The displayed dimensions are accurate to within .002 of an inch.

You can combine these options at will; thus you can select the cross-hairs cursor and have both the cursor coordinates and the size of the selected object displayed next to the cross-hairs.

The View menu also lets you choose how much of your drawing to display. You can view your drawing in the actual size it will be when printed or view the current page of *In**a**Vision*'s drawing area, which is divided into 48 8½-by-11-inch pages. The current page is the page on which you last made a change. Alternatively, you can view all 48 pages. Objects can be selected and edited in any of the View modes.

Another special capability that distinguishes *In**a**Vision* from low-end drawing packages is its Overlay feature. *In**a**Vision* allows a drawing to have up to 16 overlays. Each overlay is a separate layer of the drawing; its objects can be manipulated all at once without affecting objects on another overlay. A sample from *In**a**Vision*'s manual shows a floor plan of a building under construction. One overlay may contain only the walls and other structural features, while another might contain the plumbing for the building, and yet another the building's electrical system. The sum of all the overlays would be the entire construction plan, but the plumber, who might be interested only in where the walls are going to be and where the plumbing is supposed to go, can use the Set Overlays option to view only those two overlays.

One of the options on the Set Overlay menu is to restrict each overlay to a single color and/or fill pattern. Doing so results in every object in an overlay being drawn in the same color and fill pattern, making it



An *In**a**Vision* template file (in the right window) stores your most frequently used symbols in a clever way that makes them much easier to copy to the drawings you're currently working on (in the left window).

obvious in a multilayered drawing what level each object belongs to, no matter how many overlays are being displayed at once.

*In**a**Vision* also provides several ways to move objects between drawings. One is to simply add a second window to your screen and load another drawing into that window. Once you have done so, you can move objects between windows using the standard Windows Copy, Cut, and Paste commands.

Also, *In**a**Vision* uses a special type of window called a "template window" for storing frequently used objects, such as electrical symbols or architectural forms. Template windows are full-fledged *In**a**Vision* drawing windows, but they have two modes of operation: a standard editing mode and a special template mode.

Modes are supposedly no-no's in an easy-to-use operating environment like Windows, (the academicians say that modes confuse the user), but we'll let Micrografix sneak in a couple of modes here because the template mode is very useful. When a template window in template mode is displayed alongside a regular drawing window, all you have to do to

copy an image from the template window to the regular window is to select the object and then move the pointer to the regular window. The pointer takes on the shape of a Greek cross, signifying that a template object has been selected and will be copied to whatever location you desire. The object in the template window stays selected, so you can repeat the operation many times for a repetitive task such as drawing 144 diodes on a circuit board.

SWITCHING MODES When you want to edit a template object or add other objects to the template, place the template window into Edit mode by clicking on the word "Edit" on the menu bar at the top of the template window. The template window then has all the editing features of a regular *In**a**Vision* drawing window. To return the template window to template mode, you click on the Unedit option, an intuitive if grammatically-painful choice.

Following the introduction of its *Windows Draw* package, Micrografix released a new version of *In**a**Vision* that incorporates two of Draw's more-thoughtful features: the ability to interrupt a redraw operation and the ability to move the origin

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■ WINDOWS APPLICATIONS

■ *In*a*Vision* works equally well both with the *Windows* run-time module with which it is shipped and in the full *Microsoft Windows* operating environment.

point on a selection box or an object that's being drawn.

Being able to interrupt a redraw is important because *In*a*Vision* can take a long time to redraw the screen after you issue a command that changes the screen display. Whenever the screen display changes, such as when you zoom in on an object, resize an object, change a fill pattern, or even close a dialog box or let go of a drop down menu, *In*a*Vision* has to redraw all the objects on the screen that are affected by the change. The real answer to this problem is a graphics coprocessor, but until those become widely available, the ability to interrupt a redraw operation and make a change in the picture as soon as you realize that you haven't zoomed in enough, or that the fill pattern you selected will never do, is very useful.

Being able to move the origin point on a selection box or an object, on the other hand, is simply a practical means by which the program can help those of us who never start drawing at the right spot on the screen.

*In*a*Vision* works equally well both with the *Windows* run-time module with which it is shipped and in the full *Microsoft Windows* operating environment. Of course, using the full environment allows you to move between *In*a*Vision* and other applications within *Windows* instantly and gives you the many benefits of *Windows* Executive, *Windows'* built-in DOS manager.

*In*a*Vision* includes a number of special printer drivers. Probably the best are

its drivers for Hewlett-Packard's Laserjet and Laserjet Plus printers. The Laserjet driver produces a mixture of 150-dot-per-inch graphics and 300-dpi text on a standard Laserjet (although large drawings may overflow the Laserjet's memory capacity), while the Laserjet Plus driver produces full-page 300-dpi graphics and text.

The program disk also includes an assortment of sample drawings and symbols, plus sample symbol libraries (template files).

One small quibble I had with *In*a*Vision* is that its menu structure does not conform to the standard for *Windows* applications, in that its menu bar options appear in right-to-left order, rather than left to right. Perhaps this is because *In*a*Vision* was completed before *Windows* was finalized, but it is disconcerting not to have the File menu at the extreme left of the screen and the Edit option immediately to its right. Apple hasn't gotten many things right over the years, but its insistence on a standard and consistent interface makes learning a new Macintosh application extremely easy. The strange order of the options on the *In*a*Vision* menu, on the other hand, slows down the new user and prevents a smooth transition between *In*a*Vision* and other *Windows* applications. Microsoft should perhaps approach the *Windows* interface with some of the same didacticism Apple has used with the Macintosh interface to ensure that *Windows* achieves all of its fantastic potential.

Aside from that quibble, *In*a*Vision* is a wonderful program. It's a valuable tool for power users of graphics software, and it does a great job of using the *Windows* interface. —B. G. Waldman

Windows Draw

Micrografx's *Windows Draw* is an entry-level drawing package for the *Microsoft Windows* operating environment. Priced at only \$199, it offers the *Windows* user much of the functionality of its higher-priced sibling, *In*a*Vision*, and adds a few features of interest to the non-design professional.


Released just a short while after the first shipments of *Microsoft Windows*, *Windows Draw* was the first program to require that you own *Windows* before you


can use it. However, Micrografx found that this requirement slowed sales of the program, probably because there were no other programs that used the *Windows* environment at the time. So it quickly added the *Windows* run-time module used in *In*a*Vision* to the package, so it can now be used either alone or with *Microsoft Windows*.

Although *Draw* is more than powerful enough by itself, it is a shame to use it in standalone mode because it takes such wonderful advantage of the attributes of the *Windows* environment. For instance, you can copy text from *Microsoft's Windows Write*, the *Windows* notepad can be copied into *Draw* using the *Windows* clipboard; and pictures created in *Draw* can be copied into *Write* or other *Windows*-compatible word processors with the clipboard.

Windows Draw, like *In*a*Vision*, is an object-oriented drawing package. You can use it to create graphic images out of a collection of predefined shapes such as horizontal and vertical lines, jointed lines, freehand-drawn lines, squares, rectangles, ellipses, arcs, pie slices, and polygons. The objects you've created can be combined into larger objects, made smaller or larger, rotated, filled with various colors or patterns, moved, copied, and deleted simply by selecting them with the mouse and picking the desired choice from the menu bar.

To those capabilities, *Draw* adds one that should be of interest to almost every

**FACT FILE**



Windows Draw
Micrografx Inc.
1820 N. Greenville Ave.
Richardson, TX 75081
(800) 272-3729
List Price: \$199
Requires: 320K RAM,
two disk drives or a hard
disk, graphics board, DOS 2.0 or later.

In Short: *Windows Draw* is an excellent object-oriented drawing package. It should be of use to almost any user of *Microsoft Windows*. Not copy protected.

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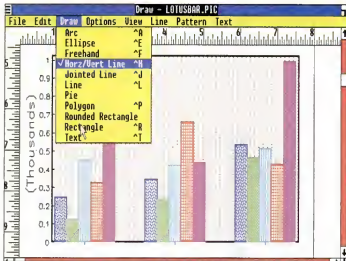
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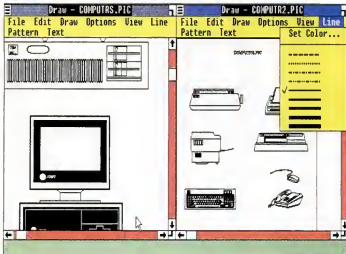
■ WINDOWS APPLICATIONS

business user: the ability to import 1-2-3 or Symphony graphics files. For instance, say you've created a basic bar chart from data within 1-2-3. Rather than struggle with 1-2-3's simplistic fonts and methods for

enhancing the graph, save the graph as a .PIC file and import it into *Windows Draw*, using the Merge Lotus Graph command from the File menu. The graph instantly appears in your *Draw* window.



Windows Draw lets you import graphs created in Lotus's 1-2-3 and improve their appearance by resizing them and adding color, different backgrounds, and a variety of label options.



You can open more than one window of images at once and transfer images from one window to another. Pictures here are from the image disks supplied with *Windows Draw*.

COLORFUL GRAPHS Once you've imported a 1-2-3 graph file, all of *Draw*'s facilities for manipulating images are at your disposal. Each bar in your sales data graph is considered a separate object, as are the graph's text labels and the box around the graph. Each object can be selected and edited individually. You might, for instance, want to change the colors of the bars to take advantage of the eight colors provided by *Windows* with an enhanced display adapter, rather than only the three used by 1-2-3. Or you might want to change the thickness of the lines that make up the box around the graph, change the text labels to a 24-point boldface italic Courier font, change the fill patterns within the bars, add a longer title to the graph, or display two or three graphs on a single page.

The end result is that your primitive 1-2-3 graph now looks like a professional product. It can be printed on any of the many printers and plotters supported by *Windows Draw*.

Aside from its ability to read Lotus graphs, *Windows Draw* is similar in its basic capabilities to many other object-oriented graphics packages and is less full-featured than some—most notably its sibling, *In*a*Vision*. For instance, it doesn't have *In*a*Vision*'s overlay capabilities, special template windows, ability to change the screen pointer to a crosshairs shape, ability to show the dimensions of an object or the pointer's screen coordinates, and so forth.

What *Draw* lacks in basic capabilities, it makes up for in ease of use. Make no mistake about it, this program is both very easy to learn and very easy to use. It conforms to all the standards of the *Windows* interface, so anyone familiar with other *Windows* applications can learn to use it very easily. Its menu bar, for instance, follows the standard left-to-right order of File then Edit before getting to its special application-specific options.

The comprehensive manual that accompanies the program also makes it easy to learn. The manual is well organized, profusely illustrated, fully indexed, and intelligently divided into a tutorial and a command-summary section. Three cheers for Micrografx for providing such a useful manual.

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■ WINDOWS APPLICATIONS

To make *Windows Draw* easy to use for even those who cannot draw very well, Micrografx includes with the program three disks containing "clip art." These are images that you are free to use in your own drawings. They include pictures of aircraft, animals, astrological signs, sample borders for pictures, computers, computer accessories, flags, office furniture, American landmarks, people, rockets, planets, road signs, space ships, ground transport vehicles, a world map, and other miscellaneous objects.

You can copy images from the clip-art disks to your own pictures simply by opening a second *Draw* window, loading the appropriate clip-art file into that window, selecting the object you want, and using the copy function to copy it to the *Windows* clipboard. Then you switch to your own drawing and select insert from the menu, once you've positioned the pointer where you want the clip-art picture to be positioned. The clip-art pictures can help make your pictures look more professional, and they're a lot of fun to play with. As with any image created with *Windows Draw*, the clip-art pictures can be edited, sized, colored, and so on.

Once you've learned how to use *Windows Draw*, the program has a number of special features—all of which are also found in *In*o*Vision*—that will make it easy to use on a regular basis. These include "accelerator" control- or function-key alternatives to almost all of the program's menu options; so instead of having to select the copy function from the Edit menu, you can simply press F2 to copy a selected image to the clipboard.

Another option that makes *Windows Draw* easy to use is its ability to interrupt a redraw operation and issue another command before a redraw operation is complete. This is very useful when you realize that you haven't zoomed in far enough, have paged down too many pages, or otherwise haven't achieved what you set out to do with your previous command. It saves you the frustration of having to watch *Windows Draw* redraw the screen before you can correct your mistake.

TIMESAVING OPTION Still another option that makes *Windows Draw* easy to use is its ability to move the origin point on

a drawing, or the block definition function. For instance, if you've chosen the Block Select option and want to be able to select several objects in order to combine them into a single object, only to realize that you started too far to the right to be able to select all the objects that you need, you simply press the rightmost mouse button to move the origin point and then continue with your operation. This feature is a real timesaver.

Windows Draw's "comprehensive undo" function is also a real boon. Most drawing programs offer an undo command that can be used only to restore the last object you have erased from the picture. *Windows Draw*'s undo function returns your picture to the state it was in prior to your last command no matter what that command was.

Like *In*o*Vision*, *Windows Draw* offers very strong printer support. It supports most popular dot matrix printers, laser printers, and plotters. It also supports a wide range of video adapter boards, including the CGA and EGA, the Hercules monochrome/graphics adapter, the AT&T 6300 enhanced adapter, the BOB 16 adapter from Persyst, and the Wyse WY-700 adapter, among others.

Windows Draw supports two standard page sizes: 8½ by 11 inches and 11 by 17 inches. It can print in either landscape or portrait mode. You can also enter custom page sizes of up to 17 by 17 inches. In portrait mode, with 8½ by 11 inch paper, your drawings can be as large as 12 pages.

When you add up all these features, it's clear that *Windows Draw* is a very powerful drawing package that should be valuable to any user of *Microsoft Windows*. Design professionals should probably buy *In*o*Vision* instead, but for any other user of *Windows*, *Windows Draw* should be considered an essential part of their software library.—B. G. Waldman

Windows Filer

Windows Filer from Palantir Software is the only data management system designed to work specifically within the *Microsoft Windows* environment. It is a flat-file database program, so it doesn't have the sophistication of a relational data manager. The report-writing facilities are fairly

good, but you do have to have something of a programmer's mentality to create complex reports. Its one outstanding quality is its ability to include pictures in a database record.

The heart of *Filer* is the form. Both files and reports are based on forms created with some simple procedures and some not-so-simple commands. When you start *Filer*, the opening screen is in the familiar *Windows* format: there is the title line, a menu bar, the blank white screen, and the icon area at the bottom of the screen. To create a file form, you use the pull-down menu under File. From the dialog box that appears on the screen, you choose the Edit selection and name your new file, and there you are at the form screen.

One nice addition *Filer* makes to the *Windows* format is the second title line under the menu bar. Here you get a line and column readout, the name of the file, and Save and Cancel buttons. The column readout helps you to see how much space you're allowing for a field. The Save and Cancel buttons are convenient, eliminating the two-step process of using a pull-down menu.

Once you're in the Edit mode, you create a file form by typing the name of the field where you want it on the screen (or page) and indicating its size with the square brackets. For most text files this is all you really need to know. When you're



FACT FILE



Windows Filer
Palantir Software
12777 Jones Rd., #100
Houston, TX 77070
(713) 955-8880
List Price: \$195

Requires: 384K RAM
(640K is recommended if

you are using multiple applications in *Microsoft Windows*), two disk drives, graphics adapter card, DOS 2.0 or later.

In Short: *Windows Filer* is a flat-file data management system based on forms. It is designed specifically for *Windows*, but it can also accept dBASE files. Its one outstanding feature is its ability to use pictures in data records. Not copy protected.

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■ WINDOWS APPLICATIONS

done, clicking on the Save button will bring up a new screen with the blank form you just created—minus the brackets. This is the record entry form.

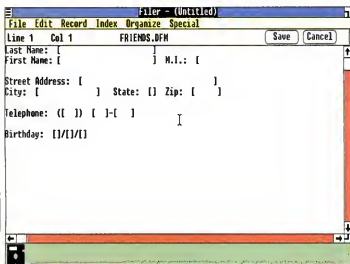
The title of your file is now on the blue

title bar. The second title bar below the menus tells you the record number you're working on. There is also a Next and Previous button for jumping between records. Adding records to the file is just like filling

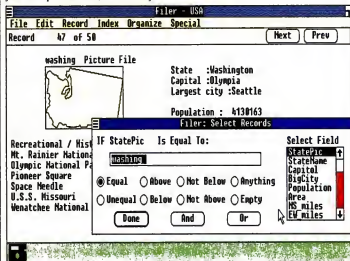
in the blanks on a paper form, except that the cursor and its attendant highlight bar jump from field to field for you as data is entered.

To create complex files that also include numerical fields, you have to add a string of command lines at the end of the file form. At the simplest level you will want to name the fields in your file form so that they can be easily referenced when you get around to writing report forms. If you don't, you will have to know the numbers of fields to write reports. There are 13 different file, or data, form commands. You also have to master the use of commas and semicolons and learn how to indicate mathematical operations in fields. The program can handle only simple math of the add, subtract, multiply, and divide variety. If you're used to *dBASE*, the *Filer* command language will seem simple. But for first-time database users, the need to do something very much like programming can make you rant and rave.

Once you have created a form and added the thicket of commands at the end of it, entering records to a file is a breeze. After opening a file all you do is choose Add from the Record menu and then fill in the blanks.



Windows Filer allows the free-form creation of database records: simply indicate the size of each field with square brackets, then save the form.



One of Filer's best features is its ability to incorporate pictures into a database. Images can be imported from other Windows programs, as well as from scanners.

INFORMATION RETRIEVAL Of course, the real power of a database program isn't in having information stored in an electronic file cabinet, it's in retrieving the information you want and in an appropriate format. The simplest search is the one that looks for one record. For example, let's say you have a customer database and you want to get the payment record of Alcazar Inc. With *Filer* you do this by using the Record Select feature on the Record menu. A dialog box that appears on the screen lets you choose the name field to search. Then you enter the company name in the text entry window, pick Equal from the Comparison menu, and click on the Done button. One note: you have to put an asterisk at the end of the name you're searching. Without it, your search will be fruitless, and unfortunately this isn't explained well in the manual (which could be better written on the whole).

Using Record Select you can generate even more-complex quick searches that might retrieve a series of records, such as

all the companies in California.

More-powerful information retrieval is accomplished by using report forms. These forms are actually little programs created with 23 different commands, comparison symbols, mathematical notation, Boolean connectors, brackets, and other symbols. Creating a report is much harder than creating a file form because there are more commands to remember—or look up—and the positioning of fields on the page becomes more critical. Complex reports will take a while to figure out, but once done they can be run over and over again, and you can create multiple reports based on one database. Of course the reports don't have to be saved and can be delivered to the screen rather than the printer. In this way you can do some simple on-the-fly retrieval of selected fields from a series of records.

One of the primary advantages to using *Filer* is that it will read *dBASE II* and *III* files. *Filer* will automatically create a data form for *dBASE* records. You can revise the layout of this form for aesthetic reasons, but you can't change the field sizes or the number of fields. You're also restricted to the number of fields in order to stay compatible with *dBASE* (32 fields per record in *dBASE II* and 128 in *dBASE III*).

The other major advantage to *Filer* is that it lets you associate pictures with data records. These pictures can be created in other *Windows* programs, like *Windows Paint*, or they can even come from a scanner that comes equipped with a *Windows* interface. The size of a picture can be controlled with the picture command at the end of the data form.

Pictures are imported by using the *Windows* clipboard feature. They are stored in a subdirectory called *Pictures*, which resides below the working directory. Because the pictures are stored in a separate file, you could deposit them in a *dBASE* file in *Filer* and still use those files back in *dBASE*.

All in all, *Windows Filer* offers features that place it somewhere in the middle ground of data management systems but with some unique features. It may be just right for people who don't need a sophisticated data manager and are working regularly in the *Windows* environment.

—Henry Fersko-Weiss

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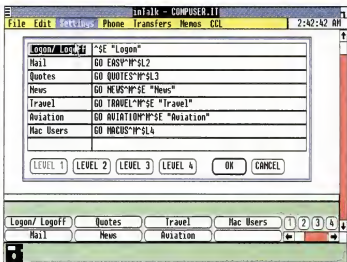
Windows inTalk

Communications programs have become fairly standardized in their approach and features. Except for some stylistic differences, they all do pretty much the same thing. The *inTalk* communications package from Palantir Software is no exception. This program doesn't break any new ground or even nudge the limits of state of the art. But it is a good, well-rounded communications package that has the added allure of working with the Windows format.

When the program is installed, it creates its own subdirectory, called *InTouch*, in the main directory of *Windows*. The program is activated by double clicking the mouse on the *INTALK.EXE* file in *InTouch*.

The first step in any communications session is to establish the transmission parameters. In *inTalk*, this is done in a Settings file that is begun by choosing the Communications option on the Settings menu. Up comes a dialog box with all the typical settings: bit-per-second rate, COM port (*Windows* allows only COM1 or COM2), number of columns, echo, and so on. You pick the parameters you need for a particular remote computer. When you're done, you click on the OK button.

The telephone number for a remote system is entered in the Phone Number dialog



The *Windows inTalk* Function Keys dialog box shows programming for the keys. Function keys can be assigned to macros containing up to 64 characters, a useful way to automate log-on sequences and other communications functions.

box, which is also reached through the Settings menu. With these few parameters, you can dial in to any other computer equipped with a modem and communications software. But *inTalk* makes your life a whole lot easier by letting you store automatic routines. These allow you to link to another computer or to one of the major electronic information services, such as Dow Jones News/Retrieval and CompuServe, by just clicking on a few menu selections.

The automatic routines are stored in on-screen function keys that appear at the bottom of the usual white *Windows* page—just above the icon area. There are eight function keys shown, but you can actually access four sets of eight keys with level indicators on the right side. Each function key holds up to 64 characters. These keys can be renamed to indicate the procedure they will carry out. For example, Level 1, Key 1 could be renamed Logon/Logoff to indicate that it sends the automatic log-on procedure to a remote computer.

The program comes with some procedures already resident in setting files that access CompuServe, Dow Jones, EasyLink, and MCI Mail. For example, in the

first level of on-screen function keys used with Dow Jones, there are procedures for accessing the news service, the main menu, and the stock quotes service. In the CompuServe file, all four levels of function keys have procedures in them for accessing the many services that CompuServe offers.

There are several ways you can download information from a remote computer. The simplest approach, if there isn't too much information, is to let the text accumulate in the buffer. You can later save what's in the buffer. You can also receive text directly by way of the printer.

Usually you will want to receive the text in a designated disk file. To do this, you choose the Receive Text File option on the Transfers menu. If you are receiving text in this way, you still see it scrolling by on the screen as it is saved to the disk.

During this process, *inTalk* allows you to control what portions of a transmission are saved. You do this by clicking on the Pause button in the status line that appears on the screen. Pause stops *inTalk* from saving information. Clicking on Resume tells *inTalk* to start saving again.

(continues on page 301)

PC FACT FILE



Windows inTalk
Palantir Software
12777 Jones Rd., #100
Houston, TX 77070
(713) 955-8880
List Price: \$195
Requires: 384K RAM
(640K is recommended if

you are using multiple applications in *Microsoft Windows*), two disk drives, graphics adapter card, DOS 2.0 or later.

In Short: *Windows inTalk* is a well-rounded communications package. It comes with a command language that enables you to automate even complex communications sessions. And because it runs in *Windows*, you can communicate in the background while running another application. Not copy protected.

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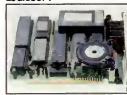
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■ WINDOWS APPLICATIONS

Sending text through *inTalk* is also done from the Transfers menu. You can send files created in *Windows Write* or *Microsoft Word* or imported from any other word processor that is capable of producing ASCII files. You can also write a message in *inTalk*, using the Memos menu. Memos gives you some basic text editing features but nothing fancy. There are no real text formatting features. While you are sending a file, the symbol of a ruler on the status line indicates how much text already has been sent.

AUTOMATIC FEATURES Naturally you can use *inTalk* in an auto-answer mode. It will receive files from other PCs as long as they are using one of three protocols: *inTalk*, *Xmodem*, or *Crosstalk*.

Most people tend to use a communications package for some very repetitive operations, like checking their MCI mailbox every morning or sending the weekly sales report back to the central office. To enable you to automate these procedures, *inTalk* has a built-in language, called the Communications Command Language (CCL). You create, edit, and execute CCL programs from the CCL menu. These mini-

programs can be quite complex, involving subroutines strung together with commands.

Using CCL programs you can automatically have *inTalk* wait until a particular time of day or night to place a call to a remote computer, send a file, hang up, and then return to DOS. Such a program is not difficult to write; there is, in fact, an example of that program in the manual. You can also do more-complex communications routines automatically. For example, you could instruct your system to call a number of different remote computers in turn, at a set time, and automatically download daily report files from them.

You can also automate communications sessions with information services, retrieving, for example, the latest price quote from Dow Jones for a particular stock. CCL programs can also be activated by using the on-screen function keys in a settings file. Some of the function keys already programmed in the CompuServe file have G commands that run CCL files. While a CCL file is being run, it will temporarily redefine the function keys, resetting them to the original when done.

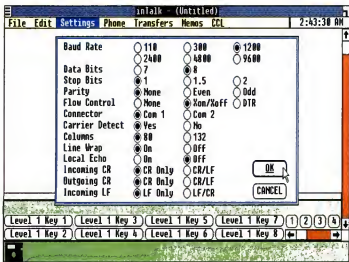
CCL takes some time to learn, especial-

■ With *inTalk* you can send files created in *Windows Write* or imported from any other word processor that is capable of producing ASCII files.

ly if you are going to create complex communications sessions. Also, as with any other programming language, CCL is unforgiving of seemingly minor errors in syntax. If a program doesn't do what you expected it to, the problem probably lies in the way you've written a command. Sometimes the error is not easy to find, so you have to proofread your CCL file meticulously. With some practice, CCL can become fairly easy to use.

Because *inTalk* is designed to run in *Windows*, you can actually run a complicated CCL program in background while you are working in another application. However, I found that having *inTalk* in a window at the same time as another program dramatically slowed down program speed. My 512K XT compatible was overwhelmed with *inTalk* and *Write* up at the same time and commuted at a snail's pace—I felt like I was using an 8088 machine again.

Palantir says that using a 640K system, and perhaps an expanded memory board as well, would greatly improve this situation. The company also says that it is exploring some kind of learn feature that would allow *inTalk* to record a communications session and then replay it whenever you want to do the same thing again—at least for some simple routines. This would save you the trouble of writing CCL files. But even without this feature, *inTalk* is a good communications program that will enable you to do almost anything you want. Plus, of course, it uses the friendly interface of *Windows*.—Henry Fersko-Weiss



The *Windows inTalk Communications* dialog box makes it easy to set such parameters as baud rate, parity, and communications ports. When you're done, you click on the OK button and move to the next box.

■ WINDOWS APPLICATIONS

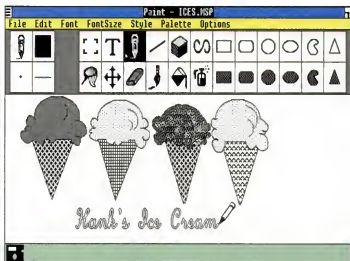
Windows Paint

Like *Windows Write* (reviewed here), *Windows Paint* comes bundled with the *Microsoft Windows* environment program. It is intended as a startup application to demonstrate the abilities of *Windows*. You won't be able to do very sophisticated work, like object-oriented drawing. But *Paint* can be quite useful for basic bit-oriented manipulation of graphics images.

Unless you're an artist—or very patient—you will probably work with pre-drawn images rather than draw your own. Images can be imported to *Paint* from almost any other graphics program. Even if the images in question aren't bit-mapped, *Windows* can capture a screen image in bit-map format and store it in the clipboard for transfer to *Paint*'s canvas. That includes programs like *1-2-3*, *Multiplan*, and most other MS-DOS programs.

Once you've imported an image, you can use all of *Paint*'s tools, patterns, and fonts to jazz up the image or to customize it for use in another file, such as *Windows Write*. Or you can just print it out.

One of the first things you might want to do with an image in *Paint* is to rearrange it. For example, if you have a pie chart in which the pieces of the pie have been exploded from the center, you may want to put them back together. You can do this by



Here's an example of a picture drawn in *Windows Paint* with script text. Options for customization of graphic designs include a choice of fill patterns and types of lines represented by drawing tools like pen nibs and spray-paint cans.

using the selection net to select the pieces and then move them to the center. Of course, if the pie is whole to start with, you can use the same method in reverse to explode the pieces.

There are two tools for moving objects around the canvas, the selection net and the selection rectangle. The rectangle is best for text or other objects that fit neatly into rectangles, while the net is good for any irregularly shaped object.

When an object has been selected with either the net or the rectangle, you can also perform a few special-effects operations, such as flipping it on a horizontal or vertical axis. Other special effects are inverting the image—which makes the background black and the lines white—or tracing the edges—which will eliminate all filled-in areas leaving only the thin outline of objects, even fill-pattern objects. The edging option can make objects look like minimalist art.

Once you've moved objects where you want them, you can add or change labels. There are two ways to approach writing in a *Paint* file. One is to write in a *Windows Write* or *Microsoft Word* file and then copy and paste the text into the *Paint* file. I

found this method to be faster because writing in *Paint* takes a lot more time. After you've written your titles or labels, it is a simple cut-and-paste operation to bring them into *Paint*.

When you have pasted text into a *Paint* file, you can drag it around on the canvas to the right position. Before you click off the selection rectangle that is around it, you can also change the text to suit your design and layout. There are eight different font selections, which include Courier, Times Roman, Helvetica and Script. You can change the font size from 6 to 84 with 25 selections in between. And then you can change the font style by using bold, outline, strikethrough, underline, or italic. You have to be careful not to click off the selection outline until you're pretty sure you have what you want because once you do, those selections can't be changed.

If you write text in the *Paint* file, you can set up the style, font, and font size before you begin. When you're done, you can still change those selections if you do it before any other operation. Once you do something else, you can change text only by erasing it and starting over again. Bear in mind that text will not wrap around in



FACT FILE

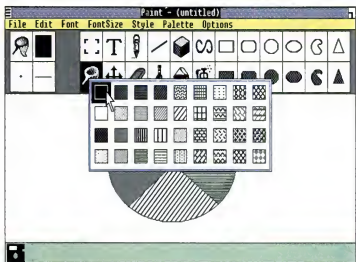


Windows Paint
Microsoft Corp.
16011 NE 36th Way
Box 97017
Redmond, WA 98073
(800) 426-9400
(206) 882-8080
List Price: \$99 (bundled with *Microsoft Windows*).

Requires: 320K RAM (512K RAM is recommended if you're going to run more than one application at a time in *Microsoft Windows*), two disk drives, graphics adapter card, DOS 2.0 or later.

In Short: *Windows Paint* is a bit-map image program that enables you to rearrange and tidy up graphics images from other programs. You can also draw images from scratch. Not copy protected.

Circle 69 on Reader Service Card



Windows Paint offers 36 fill patterns for drawings. They can be poured into a shape or spray-painted in. Pie charts can be exploded or their parts rearranged using the "selection net" pictured at the top of the screen.

Paint—one line at a time is all you get.

In addition to moving objects and adding text, you put boxes or circles around images or add fill patterns for shading. If you want to tempt the artistic fates, you can even do some freehand—or should we say free-mouse—drawing. The basic drawing tools are the pencil and the brush. The pencil line is a thin line that can't be changed except to choose one of the grid selections on the option menu. No grid means you can draw curves with only the slightest serrations on the edges, whereas choosing the Coarse Grid option restricts you to straight lines about 1/4 inch long, making curves almost impossible and certainly ungainly.

BRUSHES AND FILL PATTERNS

There are four different brush sizes, but the finest paints a line that is still thicker than the pencil line. You also have a selection of brush shapes, from little boxes to circles or lines at various angles. In addition to using the two drawing implements, you can create shapes. Your choices include line, rectangle, circle, oval, hexagon, triangle, and two types of curved lines. The shapes can be drawn as empty outlines or as filled-

in patterns. The outlines of the shapes or the lines can be drawn in four thicknesses.

There are 36 different fill patterns. Naturally, one of these is black so that you can produce solid shapes. The patterns can be added to shapes later either with the fill tool, which pours the pattern into the shape, or with the air brush tool, which adds the pattern in little circular puffs that will build up to the whole fill pattern if you keep clicking the mouse to spray an area thoroughly.

When your image is more or less complete, you can do detailed editing to clean up any unwanted edges or shakiness in your brush stroke. There is an eraser for large-scale errors, but you can't do fine work with it—partly because you need to enlarge the bits to see what you're doing and partly because the eraser is a little rectangle and thus is a poor tool for working with curves. To enlarge a portion of an image or text, you point and click the pencil to the area you want and then use the Zoom In option. This blows up a small section of the image so you can work with the individual bits, which are now 1/4-inch squares. If you place the pencil tip on a bit and then click, it will disappear. If you put

the pencil tip anywhere else on the white canvas and click, you will produce a black bit. Once you've finished touching up the image and text you're done. The final result can then be printed or cut and pasted down into another file in a Windows application. The disconcerting part of the process is that the end result still depends somewhat on your drawing ability and taste in design. No program will automatically improve these; for that, go to design school.
—Henry Fersko-Weiss


Windows Spell

A spelling checker is about as basic as you can get. But if you're phonetically deaf, it can be a wonderful utility program to have. *Windows Spell* does its basic job very well. It comes with a 65,000-root-word dictionary, which produces 130,000 word forms, making it one of the largest software dictionaries around. You can also create user dictionaries of limitless size. Moreover, it has one exceptional advantage if you are a dedicated Microsoft Windows user: it is the only spelling checking program that will run under Windows—at least for the present. Because it does run under Windows, you can spell-check any type of Windows file, from a Write file or File file, to even a Paint file.

Getting the program to work with Windows is simply a matter of copying the files on the single program disk into the Windows directory on your hard disk. Two



FACT FILE



Windows Spell
 Palantir Software
 12777 Jones Rd., #100
 Houston, TX 77070
 (713) 955-8880
 List Price: \$79.95
 Requires: 128K RAM
 in addition to the 256K
 RAM needed to run *Microsoft Windows*
 (512K is recommended), two disk drives,
 graphics adapter card, DOS 2.0 or later.

In Short: *Windows Spell* has a large dictionary and is quite fast. It is the only spelling checker that works with *Microsoft Windows*.
 Not copy protected.
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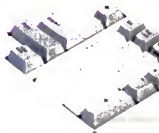
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■ WINDOWS APPLICATIONS

files, SPELL.EXE, and SPELL.LEX, will appear in the MS-DOS Executive menu. To start the program, you can either point and double click with a mouse, or simply highlight the .EXE file and hit the Enter key.

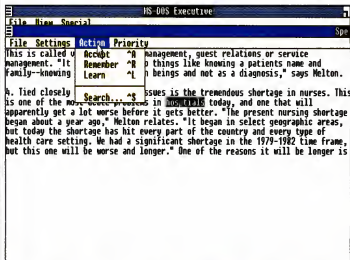
As with all Windows applications, the work area on the screen is like a blank sheet of white paper (if you're using a color monitor—and you should be). The title bar tells you that you're in the *Spell* program, and next to it is the name of the file. The menu bar has four sets of operating menus in addition to the usual Windows system menu. The system menu is the same for all Windows applications. It enables you to manipulate the window in which the program is running. If you choose the Icon option, the *Spell* window will vanish and the picture of a dictionary will appear in the icon area at the bottom of the screen. The same thing can be accomplished by pointing at the blue area of the title bar with the mouse and double clicking. The nice thing about turning the *Spell* program into an icon is that you can quickly reactivate it as a window, or by using a "hot key" combination you can invoke a small keyboard-entry window that will let you check the spelling of a word or a whole series of words while you're working on a document.

To spell-check a file, the program uses look-up routines based on the morphological components of a word (a morpheme is the smallest meaningful unit of a word). It does not rely on prefixes and suffixes, which could lead to accepting combinations that aren't words. The main dictionary in the program comes from SoftArts (as do the look-up and correction routines) and is used by Microsoft, MicroPro, Samna, Lifetree, Software Publishing, and other publishers of standalone spelling checkers. Besides the main dictionary, you can have a user dictionary as a supplementary source. The ability to create user dictionaries makes the program convenient if more than one person is using it because everyone can have his own dictionary with words he has entered. The user dictionaries can also be tied to subject areas, hence you could have a dictionary with computer terms and proper names, one with financial terms and names of all the Fortune 1000 companies, and so on.

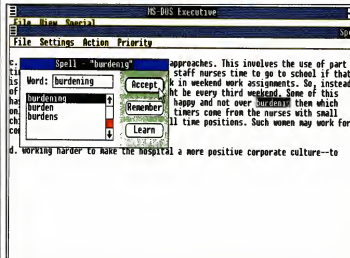
There is no operational advantage to having several user dictionaries unless one or more of the dictionaries gets very large. Then verification and correction routines may be speeded up by restricting the sup-

plementary dictionary to a particular subject area or user.

As you spell-check a file, the program will highlight the words it can't recognize, showing you the surrounding sentences as



The pull-down Action menu shows your initial choices when Windows Spell has encountered a misspelled word. The Search function displays alternative spellings.



The dialog box offers three choices: Accept replaces the word misspelling, Remember performs a global replacement, and Learn adds the word to the program's vocabulary.



PROBLEM: The more experience your hard disk has, the harder it has to work.

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■ WINDOWS APPLICATIONS

■ Since *Windows Spell* has a large dictionary and is fast, it's an excellent utility to have if you're using any *Windows* application.

well. You have four initial choices: Accept, which indicates that only that particular occurrence of the word is correct; Remember, which means the word will be accepted as is for the rest of the document; Learn, which makes the word a permanent addition to the user dictionary you're in; and Search, which locates alternative spellings of the word in question. In word searches, the program considers transpositions of letters, and phonetically similar words, and it even checks for typos that might have occurred by hitting adjacent keys. For example, if you typed *wirk*, instead of *work*, the program's correction routine would suggest a list of words that includes: *work*, *whir*, *whirl*, and *wisk*. The first and last of these choices would be the right word if you had hit a nearby key. *Whir* is a phonetic stab at the right word, and *whirl*, might have been the right choice considering both phonetics and the close proximity of the *k* and *i* keys.

Sometimes the rationale behind the search choices is a mystery. For instance, if you misspelled *correction* by typing *crection*, a search would turn up only one choice: *cremation*. But if you misspelled the same word by typing *correction*, you get nine choices—the first one would be *correction*, and not one of them would be *cremation*.

The program performs its verifications and correction searches very rapidly. I never had an uncomfortably long wait. In addition, by using the program iconically, you can spell-check very long documents while you're working on something else. The picture of the dictionary in the icon area flashes every time the program en-

counters a word that it doesn't know. Then you just call up the *Spell* window and correct it. When you are done with that word, the *Spell* window vanishes, and you are right back in the document you left. But, running the program in background like this is useful only if the document is quite large; otherwise it works too fast for you to get anything done between word checks.

Once you've done a word search, you can either pick one of the given choices or enter a new choice. At this point you have the same options you had initially: Accept, Remember, or Learn. Besides spell-checking a document file, you can work within the *Windows* clipboard. This is great if you've already spell-checked a file and are now adding a section from another document that wasn't spell-checked. Instead of having to spell-check an entire file, you can work with just the piece that was cut out.

Since *Windows Spell* has a large dictionary at its foundation and is fast, it's an excellent utility to have if you're using any *Windows* application. My only question is, "When is Palantir Software going to come out with a thesaurus?" And wouldn't it be nice if someone invented a grammar checker!—Henry Fersko-Weiss

Windows Write

Windows Write comes bundled with *Microsoft Windows* to give users something to do with *Windows* once it's installed. Because it's a giveaway product, it isn't sophisticated. Nonetheless it is a good, simple word processor that's on a par with *PFS:Write*.

With *Write* you can do all the basic editing and formatting of a text document. There are even a few extras: a search feature, a change feature, and a pop-up ruler for measuring margins. But there's no style sheet or outline, you can't get multiple columns, and you can't do indexing, a table of contents, or footnotes.

Most document editing can be done by deleting, inserting, and moving text. *Write* performs these tasks with alacrity. One of the reasons for this is the tremendous range of cursor movements that are available with either the mouse or the keyboard. A combination of the two makes for very swift positioning. You can move the cur-



FACT FILE



Windows Write
Microsoft Corp.
16011 NE 36th Way
Box 97017
Redmond, WA 98009
(800) 426-9400
(206) 882-8080

List Price: \$99 (bundled

with *Microsoft Windows*).

Requires: 320K RAM (512K is recommended if you're going to run more than one application at a time in *Windows*), two floppy disk drives, graphics adapter card, DOS 2.0 or later.

In Short: *Windows Write* comes bundled with *Windows*. Although it's free, it can perform a full complement of basic editing and formatting procedures. Plus, you can import graphics and spreadsheet data from other programs. Not copy protected.

CIRCLE 103 ON READER SERVICE CARD

sor by pointing to any space on the screen and clicking with the mouse, or you can jump around from word to word or from top to bottom of the document with combinations of the Ctrl and cursor keys or Ctrl-Home and Ctrl-End. These same motions and others let you easily mark blocks of text to be deleted, copied, or moved.

Because *Write* is designed specifically for *Windows*, you can take advantage of *Windows'* ability to split the screen horizontally or vertically—and more than once, if you care to. You can look at two files at once, easily jumping back and forth to work on them at nearly the same time or to cut and paste material between them. This is true even when you are working with a program that demands the whole screen, such as *1-2-3* does. The obvious *Windows* advantage is that you can take a chart or a graph or even a piece of a spreadsheet from a *1-2-3* file and paste it down in a *Write* document. The same goes for a *Paint* file and most other MS-DOS programs. All of the editing functions can easily be carried out from the keyboard without using the pull-down menus.

In a word processing application, it's nice to keep your hands on the keyboard and your eyes on the copy. Besides the practical advantage of working this way, it just seems faster than using menus. Take



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In brief, Cubit is an advanced software tool that automatically reduces the number of bytes required to store a file, then converts the file back to its original size when retrieved. Some programmers call this effect "data compression," others, "disk expansion." Either way, the result is the same.

Here's how it works. When Cubit compresses a file, it first compares each word to its massive English word dictionary. Words that match are reduced to a predetermined code of just one, two or three bytes each. It then saves the abbreviated version to disk. Decompression works just the opposite.

To accommodate other words and symbols, Cubit uses two more compression techniques. One assigns new, shorter codes to unusual words. Another compresses according to the frequency of character strings in non-text data. So no matter what kind of files you create, Cubit ensures maximum space savings.

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How much disk space will you save?

Because the vast majority of data created on PC's is standard ASCII text—letters, numbers and other English language symbols—we've optimized Cubit for word processing and database files. With these, you'll get a minimum of 50% expansion on up to a full 100% or more.

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Run Cubit where you want, when you want.

Maybe you'll want to use Cubit for all your files, or maybe just some. So Cubit lets you specify exactly which files to work on and which ones to leave alone.

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Save time and money, as well as disk space.

A compressed file is a smaller file. So with Cubit, back-ups

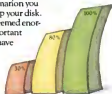
take less time, as well as less space. And communicating compressed files means significant savings on phone line charges.

Any way you look at it, Cubit will pay for itself in no time.

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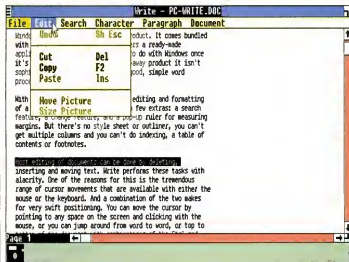
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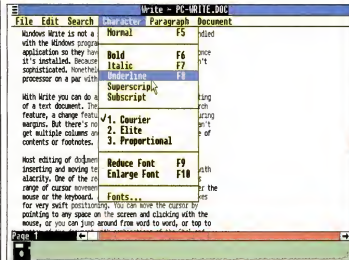
■ WINDOWS APPLICATIONS

cutting and pasting as an example. Once you've marked the text to be cut, all you do is press the F2 key. To paste that text back in the document, you position the cursor where you want it to start and simply press

the Ins key. The Ins key is also used for copying text. The same operations could have been accomplished—but more slowly—by using the Edit menu and highlighting the Cut, Paste and Copy commands.



This Windows Write file has text marked to be moved and the pull-down Edit menu showing the Cut and Copy options. Editing tasks are accomplished quickly and smoothly.



Shown here is the Windows Write pull-down character menu with the Underline option highlighted. The character menu offers different type styles and sizes that can be combined in a document.

WHEN TO MOUSE Talking about speed and the best way to perform editing operations brings us to a consideration of the mouse. You can, of course, position the cursor and mark text with the mouse; and sometimes marking with the mouse is faster than with the keyboard—when marking a long paragraph, for example. But if you're typing a report, taking your hands off the keyboard to reach for the mouse can slow you down. You have to reposition yourself to start up again.

If you choose the mouse for marking, you may find it more convenient to use it for the whole operation. However, cutting and pasting are much faster when done from the keyboard, while repositioning the cursor is often faster with the mouse.

In the end you will probably find some combination of the keyboard and the mouse that suits you best. Neither is better on its own. I found that for on-the-fly editing I like to use the keyboard alone. If I'm editing a document after it's done, I tend to rely on the mouse more and use the keyboard for just those operations it's clearly better at—like deleting and inserting text. Large document changes and formatting are usually done better with the mouse.

Some of the formatting commands are activated from dialog boxes that pop up on the screen. It's much easier to use the mouse with these commands because you get used to where they will appear and you can position the mouse arrow to anticipate the spot you need to click on, saving time.

As easy as the mouse may make some operations, you can still use Write without one. I worked from just the keyboard for weeks before I got a mouse and never missed it. As a matter of fact, for those of us accustomed to the keyboard as an interface device, skimming along the surface of text by sliding a mouse across a 9- by 7 1/4-inch metal board can be very awkward.

COMMANDS AND FORMATTING

One of the nicer extras in Write is the Change command. It sits under the Search menu heading. If you have to find and change a word (such as the name of a person or company) in many places in a document, this command is very handy. When you select from the menu, you get a dialog box in which you enter the word to find and what to change it to. Within the same

Easier Than Pie

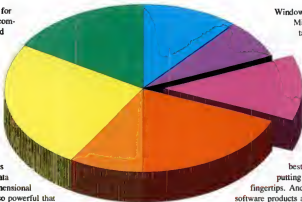
Introducing Windows GRAPH: Now the most powerful business charting program is also the easiest to use.

Choosing a charting package for your business used to be a compromise. Software either required a degree in mathematics or lacked the features to get the job done. But now, with Windows GRAPH, your ideas are no longer pie in the sky.

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Windows GRAPH is unprecedented in power and ease. Novice users can begin immediately loading data from existing spreadsheets such as 1-2-3, Multiplan, and Visicalc, and selecting default chart types from menus. Experienced users can exercise complete interactive control over customization and layout of charts, drawings, and text.

And with Windows GRAPH, you can create advanced scientific and business graphs such as log-log and semi-log variations, as well as linear, exponential, and logarithmic regressions. Even "hot-link" your graphs to another application for instant access to real-time data.



Windows GRAPH is compatible with Microsoft Windows, so you can take advantage of "state of the art" hardware and other Windows-compatible applications, such as Aldus' PageMaker, Microsoft Windows Write, Micrografix In*a*Vision, and Windows DRAW.

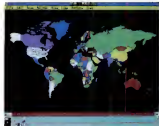
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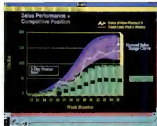
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■ WINDOWS

dialog box you can choose the Change All command, which will automatically find and change every occurrence of the word.

When it comes to formatting, *Write* offers you a number of choices in fonts and font sizes. The fonts provided with *Windows* are Courier, Helvetica, and Times Roman. Courier is a fixed-space font; the other two are proportional-space fonts. The complete font selection depends on the printer you have. If you're using a Laserjet printer, for example, you get whatever fonts come with it. However, some printer fonts do not have screen equivalents, so they share one.

Write lets you put headers and footers on every page of a document, but you will not see them until the document is printed. You can control the distance the header or footer is from the top or bottom of the page and decide if it's to start on the first page. Other formatting options are setting tabs—if you have a mouse this can be done with the pop-up ruler—and setting the left, right, top, and bottom margins. You can also automatically indent paragraphs, change the line spacing, center the text, or justify it (left, right, or both).

One of the nicest features of *Write* is really endemic to *Windows*. That is the ability to import graphics or spreadsheets from another program. For example, if you want a bar chart you've created in *1-2-3*, you would run the program, get the chart up on the screen, and then press Alt-PrtSc. The whole image will be saved and inverted from white on black to black on white. When you go to your *Write* file, you just press paste and there it is.

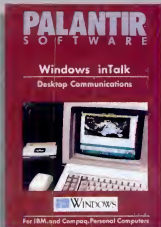
Write may be basic, but if you don't need to do fancy word processing it may be all you really need. In combination with *Windows Paint*, another *Windows* freebie, you can even create reports with graphics and text styling.

Sometimes old sayings can be wrong; in this case, you get a lot more than you pay for.—Henry Fersko-Weiss

Henry Fersko-Weiss is a writer based in New York City. Bill Machrone is editor of PC Magazine. Charles Petzold is a contributing editor of PC Magazine. B. G. Waldman is a systems consultant based in Gloucester, Massachusetts. William G. Wong is director, PC Labs.

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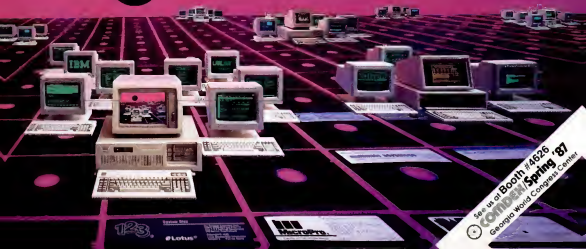
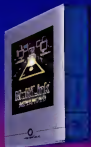
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MAKING CONNECTIONS

Clustered CPU Systems

Clustered CPUs—diskless workstations that are smaller, cheaper, quieter, and cooler than even the LANstation—combine the equipment-sharing capabilities of a typical media-sharing LAN with the physical security and centralized economies of a minicomputer. Moreover, each user in the clustered CPU system has a dedicated PC's processor and memory. One of the three clustered CPU systems we review here—the Plus4, from Alloy Computer Products, the Dimension 300, from North-Star Computers, and the OA-Link, from Our Business Machines—may make your group's workload easier to handle.

In the last issue we introduced the category of diskless workstations and reviewed six that supply full-scale computing power in a small pack-

●

Dedicated and powerful like a PC,
media-sharing like a LAN,
secure and economical like a mini,
the clustered CPU system is also
easy to use, small, quiet, and
relatively low-cost.

FRANK J. DERFLER, JR.,
AND ROBERTO RIVERA

age on each person's desk. The LANstations include a CPU, RAM, video interface, and some I/O ports in a cabinet that tucks comfortably under the monitor without raising it more than a few inches. This kind of station has the advantages of smaller size, less heat, less noise, and improved security over a standard PC with disk drives. Most LANstations also have lower prices than comparably equipped PCs and ATs.

The clustered CPU system, another type of diskless workstation, improves on even the LANstation in the areas of size, noise, heat, and cost.

The clustered CPU system gathers special CPU/ RAM/video cards together into a single cabinet. Each card offers complete dedicated PC services to its workstation—but without bringing its

■ CLUSTERED CPU SYSTEMS

■ The monitors and keyboards for clustered CPU systems are small, noiseless, ergonomically correct, and relatively inexpensive.

heat, fan noise, or power supply requirements to the workstation's location.

The same cabinet that holds the CPU cards may hold shared hard disk drives and I/O ports, or a nearby AT attached through a cable that extends the AT's data bus may supply those peripherals. One important caveat: if the shared power supply or shared hard disk drive fails in a clustered CPU system, everyone on the system loses all of his computing power.

Keyboards and monitors for the clustered CPU systems are located on the desks of individual users. Some workstations for certain brands of clustered CPU systems consist of standard PC keyboards and display monitors, but other manufacturers' workstations are specialized terminal devices. Each workstation is connected to a CPU card through one of several different cable arrangements.

The monitors and keyboards for clustered CPU systems are small, noiseless, ergonomically correct, and relatively inexpensive. Usually you can attach a printer or a modem to the workstation for local printing and communications.

Clustered CPU systems may run standard networking programs such as Novell's *NetWare*. The performance of these systems equals or surpasses that of traditional media-sharing LANs. In some cases, the cluster can be a part of a larger LAN using popular network cards, ranging from AT&T's StarLAN to 3Com's EtherLink and IBM's Token-Ring.

If you are expanding an existing network or automating a work group for the first time, clustered CPU systems can be an integrated solution with many advan-

tages over a grouping of standalone or networked PCs. Although the shared systems have a couple of common points where an equipment failure could have an impact on the total network, the same limitations apply to minicomputers, and the threat of these problems hasn't limited the use of minis. If you're expanding or integrating work group computing, you'll want to consider clustered CPU systems seriously.

ALLOY COMPUTER PRODUCTS INC.

Alloy Plus4

The Alloy Plus4 brings four specialized PC-Slave cards together into a cabinet about the size and shape of a four-slice toaster. Like a toaster, this system is hot—not in terms of degrees Fahrenheit, but in terms of performance and flexibility.

The Alloy Plus4 that we tested is a five-terminal clustered CPU system with the capability for expansion to 16 terminals. Each of its remote workstations is an integrated device that comes with a tilt/swivel screen, a separate keyboard, and an RS-232C connection back to the dedicated CPU in the cluster.

Alloy Computer Products' Plus4 system consists of the workstation monitor and keyboard, the PC-Slave/16 cards, a cabinet for the PC-Slave/16 cards, and a connection to a host computer acting as the server. Individual PC-Slave/16 cards can also be added into open slots in the server. Each PC-Slave/16 card is the equivalent of a complete PC with its own NEC V20 processor running at 8 MHz, 1 megabyte of RAM (640K bytes available to DOS), a video adapter for either a color/graphics or monochrome display, and two serial ports.

One serial port is used to connect the Alloy Plus4 workstation to the PC-Slave card, and the other port is used as a standard PC serial port, addressed as COM2. The ports have different connectors (COM2 is a standard DB-25), so they can't be easily confused.


You can start the system by installing one or two PC-Slave cards directly in the server. When more capacity is needed, you can add the Plus4 cabinet. Several Plus4 cabinets can be connected into the server's bus to create a cluster of clusters.

This flexibility to start small and increase in reasonable steps can be valuable to a growing business.

Since Alloy is well known in the tape backup business, it isn't surprising that the Plus4 cabinet includes a cassette tape unit able to back up the server's hard disk drive. The 40-megabyte tape system uses DC-2000 mini data cartridges and is compatible with Novell and MS-DOS networking software. This backup cabinet also includes the connections to the server's data bus.

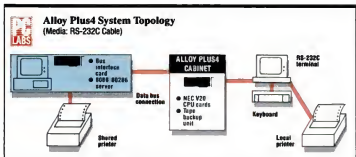
You must place the Plus4 within a few feet of the AT-type computer acting as the system server. A heavy cable goes from the Plus4 cabinet to a card in an expansion slot in the server. The server's hard and floppy disk drives and I/O ports are shared by the CPUs in the Plus4 cabinet, the server's CPU, and any other workstations in the system, such as additional PC-Slave cards in the server's bus. As is the case with any network server, the real factors that determine the response time of the network, as well as the number of workstations that the server can support, are the applications being run and how the stations are used.

Alloy markets a keyboard and monitor

**EDITOR'S CHOICE**
FACT FILE

Alloy Plus4
Alloy Computer Products Inc.
100 Pennsylvania Ave.
Framingham, MA 01701
(617) 875-6100
List Price: \$5,495, including four PC-Slave/16 cards with 1 Mbyte RAM and two serial ports each, PCII host interface card, internal APT 40-Mbyte tape backup unit, cabinet for PC-Slave/16 cards, cabling, and software; monochrome text monitor and keyboard, \$795; monochrome/graphics monitor and keyboard, \$995.
In Short: A fast, flexible five-terminal clustered CPU system with the capability for expansion to 16 terminals; each of the remote workstations is an integrated device with a tilt/swivel screen, separate keyboard, and RS-232C connection back to the dedicated CPU in the cluster. The system runs under NorthStar's N/XX, Microsoft's MS-Net, or Novell's Advanced NetWare.
CIRCLE 66 ON READER SERVICE CARD

■ CLUSTERED CPU SYSTEMS



The Alloy Plus4 system consists of (1) the workstation, which is on RS-232C terminal, (2) the PC-Slave/16 CPU cards, (3) a cabinet for these cards, and a data bus connection to an 8086/80286 computer acting as the server. The cabinet holding the CPU cards also includes a 40-megabyte tape backup unit that uses DC-2000 minicartridges. The workstation uses a serial port to connect to the PC-Slave card using RS-232C cables. You can connect one local printer to each terminal and shared printers to the server. The system runs under (4) Alloy's NTNX operating system, Novell's Advanced NetWare, or software using MS-Net modules.



system designed for use with the Plus4, but many alternatives are available. The Alloy video card and software can support a variety of RS-232C-connected terminals, such as the DEC VT-100/200 series, but if you are going to run standard PC graphics software, you should use a monitor that emulates the PC's screen.

The Plus4 workstation comes with a monochrome display. The monochrome monitor does not support high-resolution graphics, but it does display all the PC video attributes, including the extended PC character set.

The monitor supports the operation of printers at the local workstation since it includes a port for a local serial printer.

The Alloy monitor is smaller than IBM equivalents, and is particularly attractive because of its sleek styling and small size. The workstation uses a PC-XT-type keyboard.

SOFTWARE You can run Novell's Advanced NetWare with the Plus4 system, but Alloy offers the alternative of a network operating system, called *NTNX*, which works with DOS 3.1 or 3.2. *NTNX* follows standard DOS 3.x practices for file and record locking. Database management and other applications programs written for Novell's NetWare or for MS-Net systems, such as IBM's PC Local Area Network Program, run under *NTNX* without modification.

Together, DOS and *NTNX* take up approximately 142K bytes of memory in the host system. The computer chosen to be a host for the Plus4 should be in the AT class of computers with a hard disk and 640K bytes of RAM.

NTNX doesn't make use of the protected mode of operation as Novell's NetWare does, but it speeds up operation of the system in several ways. *NTNX* sets up a small buffer in DOS to help move data to and from the hard disk, but it also has the interesting ability to gather "spare" memory from the PC-Slave/16 cards to form a memory pool for disk caching and a RAMdisk. The *NTNX* configuration program allows the system administrator to allocate the memory on each card that MS-DOS can't reach (above 640K bytes) to the RAMdisk or cache. The pooled RAMdisk on the server is available to all users as a



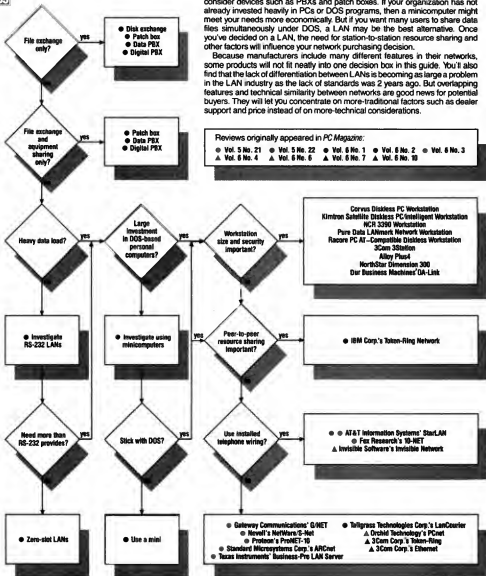
The Connectivity Decision Guide

This chart is designed to help you select from among the many information-transfer and resource-sharing alternatives. As you can see on the chart, if all you really need to do is exchange files or share printers, then you should consider devices such as PBXs and patch boxes. If your organization has not already invested heavily in PCs or DOS programs, then a minicomputer might meet your needs more economically. But if you want many users to share data files simultaneously under DOS, a LAN may be the best alternative. Once you've decided on a LAN, the need for station-to-station resource sharing and other factors will influence your network purchasing decision.

Because manufacturers include many different features in their networks, some products will not fit neatly into one decision box in this guide. You'll also find that the lack of differentiation between LANs is becoming as large a problem in the LAN industry as the lack of standards was 2 years ago. But overlapping features and technical similarity between networks are good news for potential buyers. They will let you concentrate on more-traditional factors such as dealer support and price instead of on more-technical considerations.

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CIRCLE 348 ON READER SERVICE CARD



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■ CLUSTERED CPU SYSTEMS



Clustered CPU Systems: Summary of Features

	Alley Plus4 Alley Computer Products Inc.	NorthStar Dimension 300 NorthStar Computers Inc.	DA-Link Der Business Machines
HARDWARE			
Server type	8086 80286	Dimension 300	8086 80286
WORKSTATION FEATURES			
Type	RS-232C terminal	PC monitor and keyboard	PC monitor and keyboard
CPU	NEC V20	NEC V20	NEC V20
RAM	1 Mbyte	512K bytes	256K bytes
Clock speed	8 MHz	7 MHz	6-67 MHz
Max. no. of clustered CPU stations	16	12	8
Connects to media-sharing LAN	☐	●	☐
SOFTWARE			
Runs under	NTNX	Advanced NetWare	ODOS
INSTALLATION			
Turkey		●	
Menu-driven	☐	●	☐
Documentation	■ ■ ■ ■ ■	■ ■ ■ ■ ■	■ ■ ■ ■ ■
NETWORK ADMINISTRATION			
Status reporting	■ ■ ■ ■ ■	■ ■ ■ ■ ■	■ ■ ■ ■ ■
Password protection	☐	●	☐
Security	■ ■ ■ ■ ■	■ ■ ■ ■ ■	■ ■ ■ ■ ■
Workstation operation	■ ■ ■ ■ ■	■ ■ ■ ■ ■	■ ■ ■ ■ ■
FEATURES			
File locking	●	●	☐
Station-to-station file transfer	☐	☐	●
Printer spooling/queuing	■ ■ ■ ■ ■	■ ■ ■ ■ ■	■ ■ ■ ■ ■
Peer-to-peer communications	☐	●	☐
Network dial-in	☐	●	☐
COMPATIBILITY			
RAM-resident software	●	●	●
Smart software	●	●	●

— Editor's Choice
 ● — Yes
 ☐ — No
 *Does connect under NetWare and MS-NET.

Excellent — ■ ■ ■ ■ ■
 Good — ■ ■ ■ ■ ■
 Fair — ■ ■ ■ ■ ■
 Poor — ■ ■ ■ ■ ■

shared disk drive—just like the physical disk drives. The cache program dramatically improves the response time of the network in many applications.

The Plus4's ability to use the memory DOS can't reach lets the system use economical 512K-bit RAM chip sets on its PC-Slave cards without wasting memory. As workstations are added to the system, they bring their own contribution to the efficiency of the network in the form of added memory for the common pool.

The way the network administrator arranges the network's disk drives and the files on the disk drives can significantly affect the response time of the system. NTNX can handle up to two shared disk drives. The shared disk drives can accept read-and-write file commands from all stations on the system.

Nonshared disk drives allow all stations to read their files, but only one station at a time can write to the nonshared disk. Since the system overhead used in monitoring writes to a shared disk drive is not a factor, disk access will be faster on nonshared disk drives. The wise system administrator will put program files that aren't often changed on the nonshared disk drive and put frequently updated database files on the shared drive.

NTNX and MS-DOS perform file and record locking for applications making the appropriate calls. Programs written to use the R-lock and F-lock commands get attention from a server lock buffer in NTNX that keeps track of all of the workstations' locking activity. Software running on the host PC has to make the same calls to use the resources of the system.

INSTALLATION The Plus4 hardware fits together easily. The PC-Slave cards slide into the Plus4 cabinet as they would into a PC expansion slot, and making the connection to the server is simple. The connection between the workstation and server can be made with the flat RS-232C cable that is now available from several companies. The maximum distance of the cable run depends a great deal on the electrical environment of the building. Cable lengths of 50 to 100 feet are no problem in all but the worst environments of sparking motors and buzzing fluorescent lights. In many buildings, much longer cable runs



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■ CLUSTERED CPU SYSTEMS

■ Since the Alloy Plus4 performs so well and its terminals are attractive, it should be successful in the clustered CPU market.

are possible but not guaranteed. Shielded RS-232C wiring and even fiber optic to RS-232C converters are available to help make connections in buildings with a lot of noisy electrical activity.

Installing *NTNX* requires a good working knowledge of DOS. You have to create several different types of batch files from the keyboard and understand such things as hidden DOS and copy-protected files.

Installing the software involves several steps. You have to run a program called *Prepdisk* to prepare every disk that will be a shared disk drive. It is best to run this program on a freshly formatted disk, so you might have to back up the server's disk if you already have files on it. You can use the program under certain conditions on a disk that is already formatted, but a backup is probably still a good idea. You must create a *CONFIG.SYS* file for the server with the statement *DEVICE=NX.SYS* as its first line, and you must write a new batch file or modify an existing one for each workstation's processor.

The *NTNX* configuration program lets you specify and adjust many system parameters. Setting the system configuration is a detailed job, and you'd be wise to create a written record of the original setup and later modifications. Several of the options, such as the size of the server lock file buffers, require an understanding of the file access process and some estimations of the workload. If the estimations turn out to be wrong in a few months, you might not remember why you did what you did without notes.

The Plus4 system moves data quickly. The system cache is effective, and all our

benchmark test programs ran quickly on the Plus4. Each card is polled through the network bus to determine if it has data to transmit, so in effect a deterministic protocol is used to share the network resources. As might be expected, the system experienced little degradation under heavy network load.

Combining good hardware engineering with several software options, the Plus4 offers fast service and flexibility to a large or a small work group. It's a good alternative for any level of work group activity that can be performed with MS-DOS-compatible software.

You can easily expand the system and adjust its resources to optimize the system's performance, which is excellent. Since the Alloy Plus4 performs so well and its terminals are attractive, it should be successful in the clustered CPU market.

NORTHSTAR COMPUTERS INC. NorthStar Dimension 300

NorthStar Computers, maker of the Dimension 300 clustered CPU system, was in the personal computer business years before IBM introduced the PC. The NorthStar Horizon was one of the most successful pre-IBM PC systems, but after a few early tries, the company chose not to compete head-to-head with IBM. NorthStar continued to work in OEM and industrial sales, and it used some of the technical expertise gained in the industry to develop a work group computing network with a unique approach.

NorthStar's design for a clustered CPU system puts literally everything needed to support a work group, except the keyboards and CRTs, into one box. The company makes several machines of this type, including the NorthStar Dimension 50, designed to provide small work groups of four stations with 80286-based workstations and server support; the NorthStar Dimension 300, with more expansion capacity and which we reviewed; and the Dimension 600, which, in addition to supporting the clustered CPU cards, can also be a server to a standard media-sharing local area network. The applications the workstations are running and how heavily

the workstations work the server limit the number of stations the Dimension can support. To produce a multiserver LAN, the system can also use LAN cards to link to other servers running under Novell's *NetWare*.

We evaluated the Dimension 300 system with 8088-equivalent workstation cards. The heart of the Dimension 300 multiuser system is a cabinet a little bigger than an AT that holds the combined CPU and video cards and a separate 80186 CPU running Novell's *NetWare*. The CPU cards share the internal hard and floppy disk drives and I/O ports.

The workstations consist simply of standard PC keyboards and PC monitors that are "remoted" from their CPUs by very long keyboard and video cables, with provisions to enhance the signals electrically so that they can pass over the longer wires. This combination produces a small, noiseless workstation with a familiar keyboard and display. You don't need any special software configuration or training to use familiar PC programs on the Dimension 300 system.

The hardware part of the Dimension



FACT FILE

NorthStar Dimension 300

NorthStar Computers Inc.
14680 Catalina St.
P.O. Box 500
San Leandro, CA 94577-0558
(415) 357-8500

List Prices: \$12,900, including Dimension 300 central module, 30-Mbyte hard disk drive, 60-Mbyte tape backup unit, 360K floppy disk drive, 1-Mbyte server board with NorthStar's version of Novell's *Advanced NetWare* operating system and two serial ports and one shared parallel port; Workstation-88, including monochrome monitor, keyboard, chassis. Workstation-88 card with 512K RAM, NEC V20 CPU, cabling, video card, and serial port, \$1,795.

In Short: In this fast, easy-to-use clustered CPU system, the workstations consist simply of standard PC keyboards and monitors. This setup produces a small, noiseless workstation with a familiar keyboard and display. The system runs under Novell's *Advanced NetWare*.

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CIRCLE 214 ON READER SERVICE CARD.

■ CLUSTERED CPU SYSTEMS

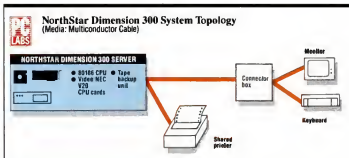
300 system consists of three major components: the central module, the NorthStar Workstation-88 or any combination of PC-compatible keyboards and monitors, and the cabling that connects the workstations to the central module.

Some multiuser computers contain a single processor that must split its time among all users. The Dimension 300 has a separate processor for each workstation and a server processor that the computer system itself uses. The separate processors and the server processor communicate through high-speed motherboard connections. The Dimension 300 system is a local area network with a very short and fast shared media running under Novell's *NetWare*.

The Dimension 300 central module comes standard with a 5 1/4-inch 360K-byte floppy disk drive and a 30-megabyte shared hard disk. The system includes a 60-megabyte tape archive system that's compatible with Novell's *NetWare*. The central module has 12 free expansion slots that can be used for NorthStar workstation CPU cards or other standard PC hardware options such as expansion RAM or an optional NorthStar controller card for a 120-megabyte second fixed disk drive. You can put a maximum of 12 workstations with clustered CPUs on this system if you don't use the slots for any other purposes.

The Dimension 300's two types of access modes to peripheral devices are dedicated and shared. In dedicated mode the device is assigned to one user at a time. If a user requests a device that is already busy, the system displays a message identifying the station currently using the device. In shared mode, more than one user can access devices simultaneously. The Novell networking software manages access to these devices to prevent conflicts.

Standard shared devices include the Dimension 300's one parallel and two serial I/O ports, which any user on the system can access. Optional shared devices perform functions such as communications or special I/O inputs. One of these devices is generally an IBM-compatible circuit board installed in the central unit. In this way, one user's CPU on the system can be "upgraded" with a device such as a mainframe communications gateway board for direct coaxial connection to a larger host



The NorthStar Dimension 300 system puts everything needed to support a work group, except keyboards and CRT's, into one proprietary box. (1) The Dimension 300 box contains combined video/NEC V20 (8088 equivalent) workstation cards and a separate 80186 CPU, a hard disk, floppy disk drives, and a 60-megabyte tape backup unit. The CPU cards for the workstations share the server's internal hard and floppy disk drives and I/O ports. To connect the Dimension 300 to the workstations, the system uses thick multiconductor cable that terminates in (2) a connector box, which, in turn, plugs into (3) the monitor, keyboard, and any local serial device. The system runs under (4) Advanced NetWare.



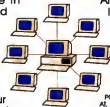
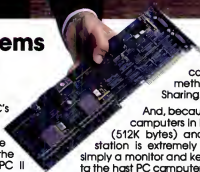


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■ CLUSTERED CPU SYSTEMS

computer. The ability to put dedicated PC-type expansion cards into the central module allows an individual user to have expansion capabilities even if his workstation doesn't have slots. The software to support the device must run in the user's CPU.

Another optional shared device is the floppy disk drive. The disk drive on the central module is available to one user at a time. A user requests access to the disk drive via the request utility in *NetWare's* public files. The user gains exclusive access on a temporary basis. The disk drive then becomes unavailable to other users until the user currently controlling it releases it.

All of the users always share the other resources. All users can simultaneously access the central module's hard disk(s). The *NetWare* operating system controls access to files stored on the shared disks. The parallel and serial ports on the central module offer shared printer or modem services to all users on the system.

WORKSTATIONS The workstation for the NorthStar Dimension 300 consists of a standard PC-XT-type keyboard and monitor. You can use any brand of PC-compatible monitor and keyboard, but NorthStar markets its own Workstation-88 with a monochrome monitor. A complete Workstation-88 installation kit contains a Workstation-88 CPU/video circuit board, a Workstation-88 cable and connector box assembly, a standard PC-type keyboard, an RS-170 video cable (for a monochrome monitor), and a hook-and-loop fastener to keep the wiring neat.

Each Workstation-88 circuit board has an 8088-2 (or NEC V20) microprocessor chip and 512K bytes of RAM. The Workstation-88 circuit board can work with either a composite monochrome monitor (RS-170) or an IBM-compatible color video output (RGB-TTL). You select the desired video output by changing a jumper block on the Workstation-88 circuit board.

The Dimension 300 and a workstation connect through a cable terminating in a device called the Workstation-88 connector box. The connector box is about the size of an AC power extension cord with four sockets. Powered separately by a small wall-mounted transformer, the connector box enhances the keyboard and



Benchmark Tests: Clustered CPU Systems

All these systems ran the same NEC V20 processor but at different speeds. The Alloy Plus4 showed surprisingly good results, even when compared with the *NetWare*-based NorthStar Dimension 300. Certainly the 8-MHz CPU processor speed of the workstations, and the 8-MHz IBM PC AT we used as the host for the Alloy Plus4, improved the system's performance. We used the same 8-MHz IBM PC AT as the host for the QA-Link system from Our Business Machines, but the Alloy Plus4 and the NorthStar Dimension 300 both used cache memory and much more sophisticated network operating systems.

The test of Network Speed Under Contention is particularly influenced by processor speed and how well the network handles batch file commands. The Alloy Plus4 flew through these tests with times we had never seen before. We attribute these results to the fast processor in the workstation and the efficiency of its cache memory.

Performance Times

(Times given in seconds)

Network plus Server Cruncher

System	Interface card	Software	Server	Zero stations	One station	Two stations	Three stations	Four stations
QA-Link	None	ODOS	8-MHz IBM PC AT	20.5	49.4	75.1	102.5	137.4
NorthStar Dimension 300	None	NorthStar's Advanced NetWare	Dimension 300	45.1	66.1	91.1	96.0	107.7
Alloy Plus4	None	NTNX	8-MHz IBM PC AT	17.2	76.3	84.6	95.5	105.7
Ethernet	EtherLink 3+Share		8-MHz IBM PC AT	44.0	63.0	79.0	96.0	112.0
ARCnet	ARCnet	Advanced NetWare-286	8-MHz IBM PC AT	59.5	65.9	73.9	110.7	126.6

Network Speed Under Contention

System	Interface card	Software	Server	Zero stations	One station	Two stations	Three stations	Four stations
QA-Link	None	ODOS	8-MHz IBM PC AT	20.5	29.4	37.0	43.5	50.3
NorthStar Dimension 300	None	NorthStar's Advanced NetWare	Dimension 300	45.1	60.0	74.2	92.0	106.8
Alloy Plus4	None	NTNX	8-MHz IBM PC AT	17.2	19.2	17.5	20.1	20.4
Ethernet	EtherLink 3+Share		8-MHz IBM PC AT	44.0	54.0	66.0	76.0	87.0
ARCnet	ARCnet	Advanced NetWare-286	8-MHz IBM PC AT	59.5	62.1	67.8	78.2	92.6

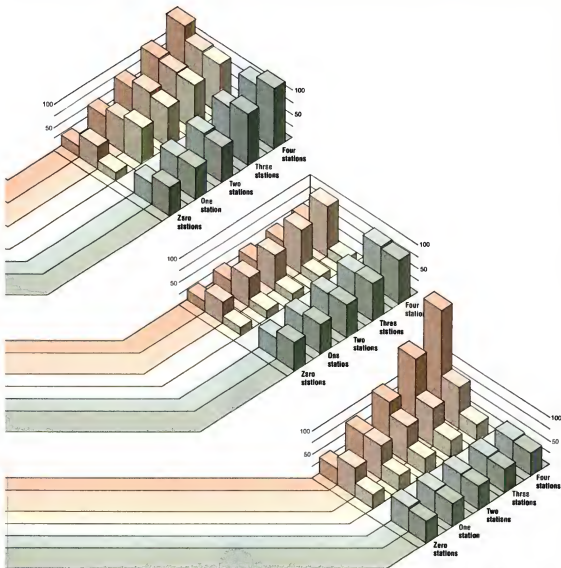
Smart Applications

System	Interface card	Software	Server	Zero stations	One station	Two stations	Three stations	Four stations
QA-Link	None	ODOS	8-MHz IBM PC AT	33.0	71.0	103.0	159.0	228.0
NorthStar Dimension 300	None	NorthStar's Advanced NetWare	Dimension 300	69.0	73.0	77.0	80.0	86.0
Alloy Plus4	None	NTNX	8-MHz IBM PC AT	28.0	33.0	34.0	38.0	38.0
Ethernet	EtherLink 3+Share		8-MHz IBM PC AT	50.0	51.0	51.0	53.0	53.0
ARCnet	ARCnet	Advanced NetWare-286	8-MHz IBM PC AT	47.0	49.5	49.5	50.5	50.5

Since we used the workstation CPUs that the manufacturers provided, instead of our standard testbed, the benchmark tests for the clustered CPU systems are not entirely comparable with the previous benchmark tests we've published. The workload is the same, but it is distributed differently among the processors. We ran all of the timing tests on one of the workstation's processors. The results of the Smart Applications tests here and those published previously, though, are comparable enough to be useful because they both include applications program processing and network access. To give you some idea of how these systems

would compare with a standard media-sharing LAN, however, we included our results from our Editor's Choice for media-sharing LANs, Standard Microsystems Corp.'s ARCnet and 3Com Corp.'s Ethernet networks (see "Making Connections: 13 LANs in Perspective," *PC Magazine*, Volume 6, Number 6). The comparisons among the clustered CPU systems themselves are a measure of how fast comparably loaded networks, with the manufacturer's workstation, work.

We evaluated the clustered CPU systems both for their performance on the network, under increasing network load, and as standalone comput-



ers. The network tests consisted of the following:
The Network Speed Under Contention benchmark test is run on the workstation under busy network conditions with many stations contending for network access. The network contention is performed using batch files that call files from the server's hard disk cache and deposit them to null. Clustered CPU systems with good I/O efficiency between the CPU card and the data bus perform well on this test. Efficient caching by the server software particularly improves performance on these tests.

The Network plus Server Cruncher bench-

mark test is run on the workstation under conditions that should put more of a load on the server's hard disk drive, data bus interface, and the networking software. The server load is performed using batch files that cause the other network stations to read files from a shared subdirectory and write them to private subdirectories. Disk caching is still a factor, but the response time of the hard disk drive and the efficiency of the networking software become more important.

For comparison, we provide the time it takes to draw files from the server under conditions of no network load and move them to other subdirecto-

ries on the server's hard disk. This test is effected by the speed of the server's hard disk, but the effect is held constant across the various workstations.

The Smart Applications benchmark test runs a timed DBMS exercise. This test is a general measure of performance because it requires calling for data through the network and locally executing the Smart DBMS program.

We evaluated the clustered CPU processors as standalone computers using the PC Labs processor benchmark tests. The benchmark tests were loaded from the server but executed in the CPU of each workstation.

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CIRCLE 153 ON READER SERVICE CARD

■ CLUSTERED CPU SYSTEMS



Benchmark Tests: Clustered CPU Cards

The combined CPU/RAM/video circuit boards in the clustered CPU systems we tested use the same NEC V20 processors and general configuration, so it is no surprise that the results of the CPU benchmark tests are similar. Overall, these boards aren't quite as fast as an 80286-based machine, but they guarantee good performance for almost all applications.

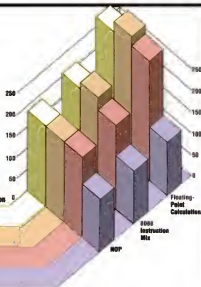
Performance Times (Times given in seconds.)

System	Software	Server	NOP	8086 Instruction Mix	Floating-Point Calculation
Alloy Plus4	N/NTX	8-MHz IBM PC AT	6.0	15.0	79.0
NorthStar Dimension 300	Advanced NetWare	Dimension 300	6.0	16.0	86.0
QA-Link	OOOS	8-MHz IBM PC AT *	6.0	14.0	80.0
8-MHz IBM PC AT	None	None	4.0	9.0	36.0

The NOP benchmark test is designed to measure raw clock speed and memory access time while minimizing differences in microprocessors and the effect of memory caching. This test executes almost nothing but NOP ("No Operation") machine code instructions in a big 128K loop.

The 8086 Instruction Mix benchmark test measures the time it takes to execute a selected series of processor-intensive tasks. The test program uses 8086 instruction code. These instructions are a subset of the total processor instruction set.

The Floating-Point Calculation benchmark test measures processor speed by looping through a series of floating-point calculations, including multiplication, division, exponentiation, and logarithmic and trigonometric functions. The benchmark program uses the floating-point library included with Microsoft C Compiler 4.0.



monitor signals so that they can travel through the longer cable.

As its name implies, the connector box is loaded with connectors. A 6-pin modular telephone jack accepts the cord from the keyboard. A 9-pin D-connector supplies the interface for a color monitor, and the RS-170 mini-jack hooks to a monochrome monitor. A 25-pin D-connector provides the RS-232C connection for any local serial device used at the workstation, such as a serial printer, a modem, or a mouse. This serial I/O device is local to the workstation, and no other user on the system can access it.

Serial printers connect to the workstation port through a "null modem," or cross-wired cable. Devices such as modems and mice (but not serial printers) that meet the RS-232C standard connect through a straight-through cable.

The maximum distance between the

central module and a workstation is 252 feet. Extension cables are available, and you can splice bulk cable to extend a standard Workstation-88 cable. Bulk cable approved for extension use is a 24-gauge composite cable containing 12 twisted pairs plus 1 pair with foil and braid shield. NorthStar recommends Belden 8112 for conduit applications and Saxton 440-12-86 for plenum-type applications.

■ **The NorthStar**
Dimension 300 is a good alternative to media-sharing LAN systems.

The Dimension 300 comes with Novell's *Advanced NetWare*, Version 2.0, loaded on the hard disk. Although you must configure *NetWare* for the users and the passwords on the system, the software requires no lengthy disk-swapping installation process.

Advanced NetWare controls communications with workstations, printers, and disk drives. Each workstation's CPU boots from the server's hard disk using *Advanced NetWare's* MS-DOS shell. The DOS shell receives user's requests, interprets them, and then communicates them to the central module or handles them itself. *Advanced NetWare*, Version 2.0, requires approximately 4 megabytes of disk space on the server for all system and public files.

You can easily configure *Advanced NetWare* to support network cards like the Corvus Omnilink and the 3Com Ether-



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■ CLUSTERED CPU SYSTEMS

Link, which you can use to add standard PCs or diskless PC LANstations to the Dimension 300 server or to link servers together.

INSTALLATION Unpacking the different components of the system took more time than actually assembling them and making the network operational. The cable for this system is many times thicker than the 3Com Ethernet coaxial cable or the AT&T StarLAN twisted-pair wire, but it is about the same size as the cable used in the 3Com Token-Ring or the IBM Token-Ring network systems.

Our only complaint about installing the system is that both ends of the cables connecting the Dimension 300 central module to the workstations have large connectors on them. This cable would be difficult to fish down walls or through cable troughs with the connectors on. You can easily run the cable across false ceilings or around baseboards, but runs that have to be fished through walls will require assembling complex connectors.

In addition to running the cables and making the connections, you must install the CPU/video boards. The only thing to check before the boards are put into the slots is that the video jumper is in the right position to select monochrome or color operation. Flipping the power switch on the server loads the networking software, and turning on the monitor begins the workstation boot process. The final installation step is for the network administrator to log on as the supervisor and customize the software system for the work group.

In theory, the tightly integrated architecture of the Dimension 300 could make it a very fast performer. Yet while it is comfortably in the top range of all the network systems we have tested so far, it didn't set any speed records. System loading affected the benchmark test numbers little, however, so this network should carry heavy processing loads well. Sometimes consistent performance is more important than top speed.

The NorthStar Dimension 300 is a powerful system, yet it is very simple to install and make operational. The network administrator must still be familiar with DOS and take precautions to ensure the security and data integrity necessary with any net-

work, but he won't have to worry about problems with networking software, hardware configuration, or installation. The keyboards and monitors that make up the workstations are familiar hardware available at competitive prices. The ability to mix the clustered CPU workstations with regular PCs on an Ethernet or similar media-sharing network gives you flexibility and a clear expansion path.

Novell's *NetWare* operating system, which the Dimension 300 runs under, is a standard in the industry, with a large base of enhancement and productivity programs supporting it. If you can install its cables easily in your office area, you'll find the NorthStar Dimension 300 a good alternative to media-sharing LAN systems.

OUR BUSINESS MACHINES

OA-Link

Local area networks give three classes of service: file exchanges, printer sharing, and access to the same data files by multiple stations. The OA-Link clustered CPU system, from Our Business Machines, supplies file exchange and printer-sharing functions in a network with up to eight small workstations, but its file access capabilities are meant for a group of disciplined friends. The system software offers no protection against file corruption or unauthorized access to data files.

The OA-Link system consists of combined CPU/RAM/video circuit boards that are inserted into expansion slots of a host PC- or AT-type computer and cables that connect the CPU cards to the workstations. The workstations consist of standard PC-style keyboards and either CGA or monochrome monitors. Our Business Machines does not provide the workstation equipment—only the special CPU cards, cable connections, and software that augments DOS. The keyboards and monitors can be PC-XT compatibles from any computer manufacturer.

OA-Link gives you an inexpensive way to share files and resources among the members of small work groups. The keyboard-plus-monitor workstations occupy a small amount of room, they are quiet, and they prohibit anyone from walking away with data on a floppy disk. As long as the members of the group follow certain rules

■ OA-Link gives you an inexpensive way to share files among the members of small work groups.

about using files, this clustered CPU system can be effective.

The host for an OA-Link system can be any kind of PC-XT, PC AT, or compatible system. It must have a minimum of 256K bytes of internal RAM memory and at least 10 megabytes of hard disk storage. The system software is designed to work with MS-DOS 3.1 or 3.2.

Each OA-Link workstation consists of a combined CPU and video card that fits into the 8-bit data bus in a PC, AT, or expansion unit, an interface box linking the user station and the connecting cable, and two cables. Each cable has a 15-pin D-connector on each end to make the connections with the interface box and the CPU card. A separate, wall-mounted AC power transformer supplies power for the interface box.

The CPU card has a NEC V20 proces-



FACT FILE

OA-Link

Our Business Machines
9698 Telstar Ave., #307
El Monte, CA 91731
(800) 433-1435 (outside Calif.)
(818) 350-0683

List Price: \$695, including 256K RAM, one serial port, one parallel port, OA-Link card with CGA chip, NEC V20 CPU, interface box; including all of the above, keyboard, and monochrome monitor, \$995.

In Short: This clustered CPU system is an inexpensive, easy way to exchange files and share printers in a network with up to eight small workstations consisting of keyboards and monitors, but it lacks software protection against file corruption or unauthorized access to data files. The system runs under Our Business Machines' *ODOS*.

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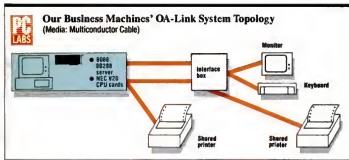
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CIRCLE 519 ON READER SERVICE CARD

■ CLUSTERED CPU SYSTEMS



Our Business Machines' OA-Link system consists of (1) combined CPU/RAM/video circuit boards that are inserted into the expansion slots of an 8086/80286 computer and (2) cables that connect the CPU cards (which contain NEC V20 processors) to the workstations through (3) an interface box. The workstations consist of standard PC-style keyboards and either CGA or monochrome monitors. The system runs under (4) the OA-Link multiuser operating system.



sor with 768K bytes of RAM (640K usable by DOS). You can set the video part of the card for either monochrome or CGA display.

The interface box looks like a shortened Hayes Smartmodem. It has the same general size and a similar silver-ridged metal cabinet. Full-size DB-25 connectors for one serial and one parallel port occupy one end of the interface box, and connectors for the monitor, keyboard, and power supply are on the other end.

If you use one of the ports on the interface box to connect to a printer, other users on the system can access that printer locally or through the network. You can use the serial port to connect a modem or a mouse or another RS-232C device.

You can expand the OA-Link multiuser system to as many as eight workstations, with a maximum distance of 200 feet between the host computer and a user station. By setting DIP switches on each workstation's CPU card, you can configure each workstation with a unique ID code (numbered 0 through 7).

INSTALLATION Installing the hardware for the OA-Link system is relatively easy. The major steps are setting DIP switches to designate the address of each workstation's CPU card, inserting the workstation CPU cards into the host's empty slots, connecting the cables to the CPU card and to the interface box, supplying power to the interface box, and connecting the monitor and the keyboard to the interface box.

The most significant drawback to the hardware part of this system is the size and bulk of the connecting cables. You could say that you trade bulky cable runs for bulky equipment on your desk, but that doesn't make the cable runs any easier to install. The cables would be difficult to fish through walls, and you would certainly have to remove and reinstall the connectors—a job calling for a soldering iron and good technique. The cabling scheme is acceptable if you can run the cables around a baseboard or through a false ceiling, but making an attractive-looking installation through the walls would be difficult.

Although the two cables running between the CPU card and the interface box

look identical and have identical connectors, they are different. Only paper labels on the cables mark their function. If the cables lost their labels, you'd need to do some sophisticated analysis or trial-and-error troubleshooting. Designing the devices with different connectors for the different cables would have been a good idea.

SOFTWARE The OA-Link multiuser operating system consists of MS-DOS 3.1 or 3.2 augmented by a floppy disk containing programs called the *ODOS* utilities. Every user on the system uses MS-DOS 3.1 or 3.2, loaded into the CPU/video card from the host's hard disk. The *ODOS* utilities furnish printer-sharing services such as displaying printer status, halting printing of local or remote files, and switching the default printer destination.

If the hardware installation is relatively easy, the software installation is simple. *ODOS* comes in a single non-copy-protected system floppy disk. The job of installing the networking software consists of copying all the files on the system floppy disk onto the boot hard disk drive of the host station. Two of the files in the system

(USER 1, for example) and the DOS prompt.

Our Business Machines' OA-Link provides two basic things: disk sharing and printer sharing. Each workstation on the system has one logical disk drive (C:), which is the host's hard disk. You can use the server's keyboard to move files between the C: drive and a floppy disk on the A: drive. Each workstation has access to every file on the shared disk. The OA-Link operating system does nothing to prevent one user from modifying or deleting every other user's files on the shared disk.

The latest versions of DOS have a few file protection capabilities, such as file locking or the ATTRIB command. You must invoke the file-locking capabilities, however, as part of a relatively sophisticated database management scheme, and anyone can use the DOS ATTRIB command to make a file read/write or read only.

PROTECTING DATA The best approach to using OA-Link in a work group is probably to assign each user to a subdirectory and to let only the system administrator make transfers between subdirectories. The nature of the work group will determine how successful this kind of policy will be, because the network supplies no software to enforce it.

The *ODOS* utilities provide basic printer services, such as displaying printer status, halting printing of files, and printer switching. A three-character sequence enables a user to send output to any printer on the network. Each serial and parallel port on the workstation interface box has a unique three-character name consisting of Ctrl-Alt-#, where # is the designated port number.

For example, anyone on the network can access the printer attached to the parallel port on user 0's interface box by pressing the Ctrl, Alt, and 0 keys. User 0's serial port is accessed by pressing the Ctrl, Alt, and 4 keys. The host computer's first printer port is designated as port number 7, the host's second printer port is number 8, and so on. The concept is simple and the system works, but the details of operation can require using an operating aid, locally written on a piece of paper, at every workstation.

PC EDITOR'S CHOICE

• Alloy Plus4

The Alloy Plus4 system is the hands-down winner for performance. We also like the idea of extending RS-232C wiring more than we do extending keyboard and video cables, as you must do with the other two systems reviewed. The ability to use Novell's Advanced NetWare on this system is also valuable.

In DOS-related tasks that don't depend on disk caching, the OA-Link system performed as well as IBM PC standard workstations operating on more expensive media-sharing LANs. Its performance slowed down considerably under the record- and file-locking workload provided by the Smart Applications LAN benchmark tests. Judging it from a performance standpoint, this system is adequate to support a small group that is, for example, manipulating spreadsheets or doing some types of word processing that don't place a heavy load on the server's hard disk. It lacks the software features needed to support heavy printer-sharing or access to the same files by more than one station at a time.

Installing the hardware for the OA-Link is easy as long as the work area is small and open. Installing the software is simple, too. Except for printer sharing, the operating system is standard DOS. Sharing printers requires remembering or looking up a few keystroke combinations. This system is a practical way to share resources and exchange files in small work groups, but it comes with a significant vulnerability: the lack of any security, file management, or file protection beyond DOS. OA-Link expects users to play by the rules. [E]

Frank J. Derfler, Jr., is a contributing editor of PC Magazine. Roberto Rivera is an in-house computer consultant for George Mason University. He has also worked as a network applications programmer for Chase and Arlington located in Rosslyn, Virginia.

■ The OA-Link system lacks the software features needed to support heavy printer-sharing or access to the same files by more than one station at a time.

disk are an AUTOEXEC.BAT file that loads the RAM-resident Network Operating System and a CONFIG.SYS file that makes the network environment a system device.

Once the host station is up, you can power-up the workstations by turning on the monitor and the power switch on the interface box. At boot-up, each workstation monitor displays a user ID code

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Vincent Puglia PC Magazine Vol. 6 #3

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Winn L. Rosch
PC Magazine Vol 8-3

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COMMODORE COMES HOME

The market for silicon shelf-paper—those cheap pseudo-computers that proved to be more closet-bound dust-catchers than desktop data-manglers—has tormented the best of computer makers. Finding a success among the manufacturers of the so-called home computers that were popular a few years ago is a chore as thankless as sending Diogenes looking for an honest man. The casualties are many: Atari's 400 and 800, Coleco's Adam, Mattel's various models, Texas Instruments' TI99, and even IBM's PCjr.

Commodore ranks as the sole survivor from that era of marketing errors—its C64 is the only machine from the home computer's heyday that's still being sold. Yet even Commodore hasn't escaped un-

scathed. The company's C128, the assumed successor to the C64, was welcomed by the remaining home computer market with the warmth normally accorded to in-laws. The aging C64 endures as Commodore's top-selling system.

Commodore thus has the dubious distinction of being the leader in a disappearing market. It's the sort of situation that makes accountants talk about negative growth rates and executives test their flying abilities from sixteenth story window ledges. Something has to be done: a new strategy thought out, a new market found.

Enter the PC10-1 and PC10-2, new and revolutionary machines for Commodore—at least at first thought—totally unlike anything that the company has ever before sold in America. Instead of the go-it-alone designs of the C64 or C128, the

*Riding the waves of its success in Europe and Canada,
Commodore brings its PC-10 to the U.S., where
it's setting its sights on the business PC-compatible market.*

■ COMMODORE PC10



Benchmark Tests: Commodore PC10-1 vs. IBM PC-XT

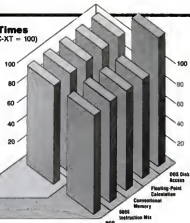
The Commodore PC10-1's performance matches the floppy-disk model IBM PC-XT. At \$999 for a basic 512K, single-floppy-disk model, the PC10-1 offers full expandability at one of the lowest prices on the market.

Performance Times

(Times given in seconds except where noted)

	NOP	8086 Instruction Mix	Conventional Memory	Floating-Point Calculation	DOS Disk Access (milliseconds)
IBM PC-XT	10.10	32.00	5.95	159.70	234.70
Commodore PC10-1	10.10	32.70	6.00	159.70	304.50

Relative Times
(Ratio: IBM PC-XT = 100)



The NOP benchmark test is designed to measure raw clock speed and memory access time while minimizing differences in microprocessors and the effect of memory caching. This test executes almost nothing but NOP ("No Operation") machine code instructions in a big 128K loop.

The 8086 Instruction Mix benchmark test measures the time it takes to execute a selected series of processor-intensive tasks. The test program uses 8086 instruction code. These instructions are a subset of the total processor instruction set.

The Conventional Memory benchmark test allocates 256K bytes of conventional memory and treats it as a series of 64-byte records. Then, 16,384 random records are read into and written from this memory. The result shown is the average of the read and write times.

The Floating-Point Calculation benchmark test measures processor speed by looping through a series of floating-point calculations, including multiplication, division, exponentiation, and logarithmic and trigonometric functions. The benchmark program uses the floating-point library included with Microsoft C Compiler 4.0.

The DOS Disk Access benchmark test measures the time it takes to do a random sector read using DOS. DOS buffers are set at 3 and the interleaved factor is left at the drive's default setting. This test adds DOS's overhead to the BIOS and hardware times. The test program performs the sector read 1,000 times within the DOS disk partition. The average result is shown in milliseconds.

PC10s are merely new additions to the pack of PC clones, conformists rather than individualists, fitting a standard rather than making their own. Moreover, the PC10s are not at all like Commodore's cheap home computers of yesteryear but are built in Taiwan on a business machine base. The strategy they embody seems plain: in America, Commodore is moving from the living room into the burgeoning business computer market.

In truth, Commodore is new neither to the business computer industry nor to the PC-compatibles market. Remember that one of the company's many monikers is Commodore Business Machines. And the European arm of the multinational computer company boasts one of the market-leading desktop business machines on the Continent.

The idea of moving into budget-priced business machines probably did not require great enlightenment on the part of any Commodore executive, however. The success of other such low-cost machines has been as phenomenal as it was unanticipated. For instance, the Leading Edge Model D remains backordered for months because supply cannot meet a demand un-

foreseen in its makers' wildest dreams.

The PC10s are aimed at exactly the same market as are the Leading Edge Model D, the Epson Equity 1, and the Tandy Model 1000—a marketplace where price means more than anything else, particularly performance. Their introduction at the Consumer Electronics Show in Las Vegas last January confirms the marketing aim for the PC10s. At the time, those

wanting to get their hands on cheap clones were frustrated by the lack of available merchandise. Commodore aimed to take up the slack in supply.

Dig into their cases and you'll find evidence that the PC10s were merely waiting for a propitious moment or some powerful motivating force to push them onto the American market. The system board is plainly silk-screened with the legend "Copyright 1985 Commodore." That's going way back for a 1987-vintage introduction, an unusually long gestation in a market where products are often introduced before the first pen touches down on the plans. The reason is simple: the PC10s are computers that have come in from the cold of Europe and Canada. Up north, the identical Commodore computer is the top-selling PC-compatible. In Europe, and particularly Germany, it also ranks near the head of the list.

The marketing ploy and timing of the introduction should guarantee such sure-fire success that the PC10s probably won't have to be very good computers to be money-makers for Commodore. Remarkably, however, the two PC10s just happen to be very competent (though perhaps dated)



FACT FILE

Commodore PC10-1
Commodore PC10-2
Commodore Business Machines Inc.

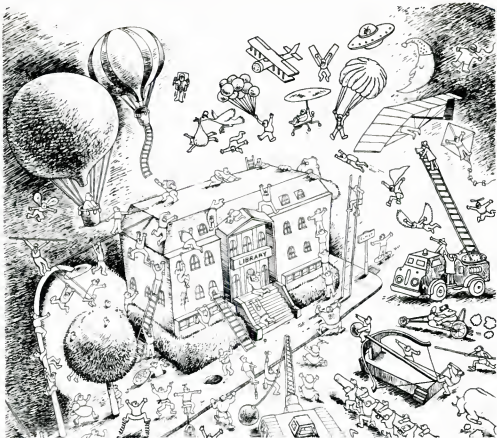
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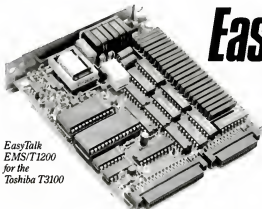
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■ COMMODORE PC10



The Commodore PC10-1, pictured above, is equipped with 512K bytes of RAM and one floppy disk drive. The PC10-2 comes with 640K bytes of RAM and a second floppy disk drive. Monitors for both models are not included in the base price.



machines capable of running whatever ordinary PC applications you load into them. They're good enough, in fact, that you'll undoubtedly see these machines plugging away on desktops in small businesses and cost-conscious corporations all across the country despite the homey American reputation of their maker.

Overall, they rate as a good choice for applications in which performance counts least. Compared to some of the other cut-throat PC clones, they also offer unusually good expansion possibilities: four free slots out of a total of five, space awaiting a

hard disk, and a big enough power supply to take care of most options. Their sole shortcoming is that, at their current prices, they might not be cheap enough to compete effectively against the new wave of clones selling at \$500 to \$700. But savage discounting—something Commodore computers are well accustomed to—holds the promise of making the PC10s market leaders.

UNREMARKABLE OLD FRIEND The differences between the two PC10 models are threefold: drives, memory, and price.

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■ COMMODORE PC10

The PC10-1 is the more modest effort, equipped with a single floppy disk drive, 512K bytes of RAM, and a \$999 price tag that lets you instantly imagine the headlines on the press releases: "Full PC com-

patibility for under \$1,000." The PC10-2 is a step-up model that adds a second disk drive and 128K bytes of RAM (making the memory total 640K) to the machine and \$200 to the price tag.

Except in respect to the manufacturer, neither PC10 model rates as a milestone machine. Both are quite ordinary PC compatibles, hardly newsmakers in a world dazzled by the performance of the 80386 microprocessor.

Central to each is the same brain, the 8088 microprocessor, running at the 4.77-MHz rate that's standard for IBM PCs and PC-XTs. Performance is pedestrian compared to the glory machines in today's PC universe, exactly equivalent to the speed of a first-generation PC.

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■ Except in respect to the manufacturer, neither PC10 model rates as a milestone machine.

coprocessor. It will probably be used by folks who like to turbocharge their Chevettes or Citroen 2CVs.

Functional differences from the IBM PC or any other popular clone are trivial. The PC-10s will run any version of DOS, including PC-DOS 3.2, and any program that doesn't depend on the BASIC module that IBM builds into its system ROMs. But you won't have to bother with PC-DOS or worry about BASIC because both machines come complete with MS-DOS 3.2 and GW-BASIC as standard equipment. Commodore also includes a copy of the *SideKick* desktop utility package.

Turn on a PC10, and you'll see a slightly more informative screen than the flashing cursor the PC gives you at power-up. The PC10s list their port assignments and count through memory as it is checked so you know that something is actually happening while you wait through the self-test. In about 30 seconds, each machine announces all's well with a quirky, chirpy trill and boots up from drive A:. From then on, you'll be dealing with the DOS you've grown to love/hate/endure.

On the outside, the PC10 looks like a

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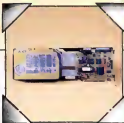
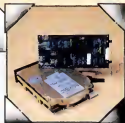
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■ COMMODORE PC10

stylish update of IBM's original PC design. It's still a needlessly big, rectangular box, PC-size (5½ by 19 by 15½ inches), mostly made from sheet metal.

The front panel is plain beige plastic and devoid of ventilation slots. A gray nameplate and a right-hand drive bay large enough to hold two 5¼ inch half-height floppy disk drives adorn the front. A narrow crease near the top of its flat face ties the two built-in indicator LEDs—red for power on and green for hard disk drive activity—to the drive bay. Just under the front panel overhang is a jack to which the keyboard connects.

The back of the machine looks equally Spartan. Besides the five retaining brackets of the internal expansion slots, only two connectors (the built-in parallel and serial ports), a small black rocker switch to turn the power on and off, and a jack for the power cord are visible. No AC jack for plugging in a monochrome display is available. The connectors for the two ports both follow the PC-XT standard, a female DB-25 for the parallel and a male DB-25 for the serial.

The thin steel lid of the case is secured by five Phillips-head screws in the rear and two more at either side near the front. The top of the case slides backwards easily and lifts off, allowing access to the machine's innards.

WIDE OPEN SPACES Inside, the PC10s look almost as if someone forgot to put the computer in. They're spacious and empty, resembling more a dirigible designer's work than a computer engineer's. If you're installing options, that's good: you'll have room to work and few worries about slicing your hands open trying to shoehorn a disk drive into a cramped cage. If your desktop is crowded, however, the wasted space is annoying. More than a full inch of the case could have been carved off without compromising any of the internal functionality, or the extra area could have been devoted to an additional expansion slot. Were Commodore simply to limit mass storage options to hard disk cards, more than 6 inches could be chopped off the chunky chassis.

One reason for the bare look inside the case is that both port support circuitry and the floppy disk adapter are built into the

PC10 system board. The sole feature lacking from this native endowment is a built-in time-of-day clock.

The only genuine expansion board included or required by either PC10 is an ATI Technologies Graphics Solution, a 5-inch-long card in the leftmost slot. This standard-equipment video adapter mimics the IBM Monochrome Display Adapter, Hercules Graphics Adapter, IBM Color/

■ Inside, the PC10s look almost as if someone forgot to put the computer in. They're spacious and empty.

Graphics Adapter, and Plantronics Color Board, so you can plug just about any monitor into either PC10.

The layout of the L-shaped PC10 system board is neat and its quality is high. Its circuitry is not densely packed nor does there seem to be much of it. You'll find almost no custom LSI (large scale integration) chips; nearly everything is a stock catalog item. Unlike the bargain Commodore computers, this one uses top-quality components, like a glass-epoxy (instead of a phenolic) circuit board, just as you would expect in any quality compatible. Its liberal use of circuit-board real estate should guarantee reliable operation, particularly considering the modest performance demands made on it.

The system BIOS is stuffed into a single socketed ROM chip and no vacant sockets are provided for expansion ROM. Its internal copyright attributes development to the joint efforts of Commodore Electronics Ltd. and Phoenix Software Associates Ltd. It proved both well-behaved and extremely compatible and exhibited no problems running any standard DOS software.

Only 256K of the total system memory is built into the system board, in the guise of one parity-checked bank of nine 256K-bit DRAM chips. The balance of the sys-

tem memory is contained on a small proprietary daughter card just inside the innermost standard expansion slot.

In the PC10-2, this card is equipped with one bank of nine 256K-bit chips and another bank of six 4- by 64K-bit chips, all soldered down, yielding a total of 384K. In the PC10-1, six sockets are substituted for the latter group of chips so you can later add on when the desire moves you (and when you can find the moderately rare memory chips).

DRIVE AROUND THE BAY Another reason for the vacant look of the inner PC10 is its internal drive bay. An unfinished steel shelf next to the floppy disk drives, this internal bay should be able to accommodate any full or half-height hard disk. The hard disk mounts by directly screwing it to a folded-over lip of the drive mounting shelf.

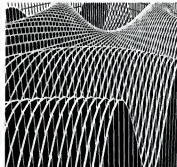
The internal bay is actually wider than a standard 5¼-inch form factor drive (that's where an inch could be shaved off the chassis). That, together with the loud-speaker mounting scheme (the speaker is screwed to the left side of the internal bay), limit mounting the hardware for the hard disk to two screws near its bottom on one side. Thus, you can't easily install more than one half-height drive even though two should fit, theoretically.

Commodore obviously intends this internal bay to be used for a hard disk. The manufacturer even includes an outside drive activity indicator complete with cable to plug into your disk drive. The 110-watt output power supply of the PC10s should be sufficient to run all but the most greedy disk drives. However, Commodore skimps on power connectors, supplying only two, both used by the PC10-2 floppy drives. You'll need a wye cable (or a hard disk card) to add a Winchester drive.

GETTING SET UP Hardware configuration of either PC10 requires setting a single DIP switch bank on the system board to indicate the number of floppy disk drives, monitor type, memory, and whether a 8087 is present. All machines are set up at the factory to reflect their installed options—with one exception. All PC10 systems are configured for monochrome

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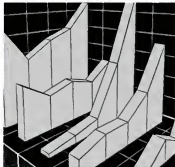
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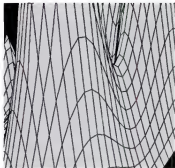
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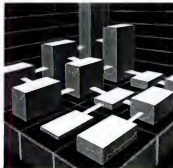
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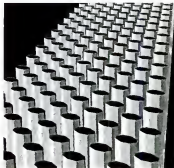
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■ COMMODORE PC10

monitors no matter what type of monitor they're sold with. If you're using a color display, you'll have to reset the system board switches as well as the ATI video board to reflect your monitor choice. Fail-

ure to do so may result in monitor damage.

Changing the monitor setting is a two-step procedure. You must alter a DIP switch on the ATI Graphics Solution and flip another one on the Commodore sys-

tem board. The accompanying documentation does not make the matter easy.

The entire hardware setup procedure is badly covered in a poorly structured series of appendices. Overall, the spiral-bound manuals, a combined operations and DOS book and a GW-BASIC reference, seem aimed more at Commodore's traditional American hacker market than the neophyte user or the business community.

In the same barely adequate vein is the Commodore keyboard. Its layout is a variation of the original IBM PC AT design with enlarged Enter and Shift keys, ten left-hand functions, and a combined numeric/cursor keypad. For some mysterious reason, however, other keys have turned nomad. Inexplicably, Alt lies to the left of

■ The PC10s are plug-compatible with standard IBM PC keyboards and compatibles.

Ctrl, above the Left Shift. Esc is where it belongs, upper left, but Backslash is to the right of the Left Shift and PrtSc lies in the cup of the Enter key. Commodore has also added a dedicated Break key.

The touch of the PC-10's keys is somewhat stiff with a linear feel. There is no tactile or audible feedback. The keyboard mechanism appears to be of the hard contact type, which is generally not as long-lived as the capacitive designs of other manufacturers. It also appears to be based on an inexpensive phenolic circuit board.

Fortunately, the PC10s are plug-compatible with standard IBM PC keyboards and compatibles. Buy a PC10 and odds are you'll want to invest in a replacement keyboard sooner or later.

The review PC10-2 was accompanied by a Japanese-made Commodore 1902 monitor that retails for \$349.95. It was a pleasant surprise and a delightful contrast to the keyboard. A triple-purpose color display, the 1902 accepts IBM-style RGB, Commodore 64-style split video, and ordinary composite video inputs. Its sharpness

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■ COMMODORE PC10

and color saturation appear equal to IBM's Personal Computer Color Display even in 640 by 200 mode. Its styling, however, is more like that of a television set—an upright rectangle with a straight, vertical face. The finish of its plastic cabinet is a pleasing, businesslike pale gray beige, with the around-the-screen bezel tinted a darker accent gray shade.

A speaker and amplifier are built into the 1902, but, as with most other PC compatibles (except for the PCjr), the PC10s have no audio output that would make use of the sound capabilities of the monitor.

A wealth of user controls, including horizontal position, vertical hold, color, tint, brightness, contrast, volume, and three-position video mode, are hidden be-

■ In the price-is-everything market in which they compete, the PC10s rate as strong contestants.

hind a hinged door at the lower left of the 1902's front face. A power-on push-button switch and a pilot lamp are visible at the lower right corner. At rear are a female DB-9 connector for the RGB input, three RCA pin jacks for the split video, composite and audio inputs, and a positive/negative sync select switch for the RGB input.

BACK TO THE FUTURE While in many ways the PC10s appear to be computers designed for the demands of yesterday using the technology of half a decade ago, they do hold the potential of enlarging the PC market even further. In the price-is-everything market in which they compete, they rate as strong contestants. Although their performance is merely adequate, the PC10s have no inherent handicaps. All true PC expansion options are open to them, unlike some competing products which limit expansion board length, the number of boards, or the type of disk expansion.

With some clones selling at street prices half the suggested retail of the PC10s, the future of these Commodore machines appears doubtful. But if the PC10s are offered at the same deep discounts as are oth-

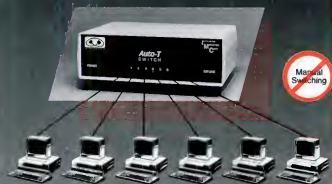
er Commodore products, they may just prove to be runaway successes.

Winn L. Rosch is a contributing editor of PC Magazine.

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■ PC LAB NOTES: TURBO BASIC ■ ETHAN WINER

TURBOCHARGING BASIC, PART 2

In this continuation from Volume 6 Number 9, we look at both new commands and recursive functions, test Turbo BASIC against QB2, and give an inside look at a great program.

In Part 1 of this article I discussed many of the concepts that contribute to Turbo BASIC's superiority over other compilers. But in addition to fast printing, binary disk access, and many other important features, Turbo has also added a number of extensions to the language itself. These new commands will be the focus of this second part. In addition, I'll give you a closer look at recursion, the assembly language interface, and some benchmark test comparisons with QuickBASIC.

Unlike many other recent BASICs, Borland wisely chose not to attempt to redefine the language. Where True BASIC has arbitrarily changed a number of keywords and most of the other BASICs stray considerably in their handling of graphics and I/O, Turbo BASIC instead builds on Microsoft's established standard. Therefore, conversion from BASICOM or QuickBASIC to Turbo is a relatively painless proposition, and the additional commands and capabilities are but icing on the cake.

CEIL BASIC has always included an Int function to truncate a value. Turbo BASIC, however, has added a Ceil function to find the next higher integer amount. In the past, this was generally done by adding 1 to the value and then taking the Int of that. However, if the number was already an integer, then the result would be incorrect, as is shown in Figure 1. By using Ceil, however (Figure 2), the correct answer can be easily found without additional testing.

INCR AND DECR Another useful pair of new commands in Borland's Turbo BASIC is Incr and Decr, which allow incrementing or decrementing a variable directly. Although you could, of course, always add or subtract 1 to a variable, using Incr and Decr is more to the point and may more accurately reflect the program's logic in certain situations. Note that both Incr and Decr also accept an optional step size, allowing values other than 1—a welcome addition, indeed.

```
Value = 12
Incr Value          'now Value = 13
Incr Value, 3       'now Value = 16
Decr Value          'now Value = 15
```

DELAY Also new in Turbo is the Delay command, which lets you specify how long to pause a program's execution. Previously, this was often done using the Timer function:

```
X = Timer
While Timer < X+2 '2 seconds
Wend
```

Delay, however, does it directly:

```
Delay 2             '2 seconds
Delay 1.25          '1-1/4 seconds
```

UCASE\$ and LCASE\$ Yet another useful pair of additions is UCASE\$ and LCASE\$, which convert strings to all upper- or lowercase. Of course, only characters are converted, leaving numbers and punctuation unchanged. You would convert a string to all capital letters thus:

```
XS = UCASE$(XS)
```

And to make a lowercase copy without altering the original string, you would use

```
YS = LCASE$(XS)
```

INSTAT One more Turbo goodie is the new Instat function, which reports if a key-stroke is waiting in the buffer. True, you could always use something like

```
If Inkey$ <> "" Then . . .
```

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Turbo BASIC's new assembler interface and recursion abilities.

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■ PC LAB NOTES

Instat is more to the point, as well as being substantially faster, especially if you are repeatedly polling the keyboard while doing something else.

```
If Instat Then . . .
```

Perhaps the biggest benefit of Instat, however, lies in the fact that it does not remove the current character from the keyboard buffer. I generally pause for a keystroke by using While and Wend:

```
While Inkey$ = "" : Wend
```

This produces the tightest (and simplest) BASIC code. But when you need to know which key had been pressed, this doesn't work: the very use of Inkey\$ gobbles up the pending character. In such cases you are forced to use a less elegant loop:

```
Get.Key
```

```
XS = Inkey$
```

```
If XS = "" Goto Get.Key
```

With Instat, that can be replaced with

```
'pause for a keypress
While Not Instat : Wend
'now get the key
XS = Inkey$
```

EXP2 AND EXP10 Turbo has supplied two new forms for the Exp function. Where the original Exp will raise the number *e* to a specified power, Exp2 and Exp10 use either base 2 or base 10 for their calculations. Thus

```
X = Exp2(7)
```

is functionally equivalent to

```
X = 2 ^ 7
```

While this doesn't exactly save keystrokes, it complements the more important new math functions, Log2 and Log10, the latter of which is dear to every EE.

&B AND BIN\$ Another nice touch is the addition of &B (and its corresponding Bin\$) for binary numbers. &H and &O let you specify numbers in hex or octal, and &B allows you to enter a string of ones and zeros when appropriate. I like that.

NO LINKING One of the reasons Turbo BASIC can create finished programs so quickly is that it eliminates the link step

```
X = 4.3
Print Int(X + 1)           'prints 5, correct

X = 7
Print Int(X + 1)           'prints 8, wrong!

If X <> Int(X) Then        'the only real way to be sure
  Print Int(X + 1)
Else
  Print X
End If
```

Figure 1: Using Int to find the next higher value can sometimes fail.

```
X = 4.3
Print Ceil(X)              'prints 5, correct.

X = 7
Print Ceil(X)              'prints 7, correct
```

Figure 2: Turbo's new Ceil function always gives the correct answer.

```
***** Program.Bas by Lucy Brown
*
* main body of the program
*
$Segment
*
* a collection of I/O subprograms
*
$Segment
*
* more subprograms
*
```

Figure 3: The \$Segment metastatement overcomes the usual 64K limit.

that is usually required. In the past, the only way you could write very large programs was to create a series of separate .OBJ program modules and then combine them with the linker. Turbo BASIC lets you skip all that and simply create the entire program in one step. But since the 8088 family processors impose their own limit on the size of a single code segment, you must still indicate a "logical" break point. This is done with the \$Segment metastatement.

As you are developing a program, rather than physically dividing it into separate modules, you instead tell Turbo BASIC where to begin a new code segment. This is only necessary if you believe that a 64K boundary is about to be reached, or when the compiler reports an error to that effect. The usual place to insert the \$Segment

metastatement would be at some logical break in the program's design—for example, at each major section of code. This is illustrated in Figure 3.

Notice that the Turbo editor, like most editors for the PC, cannot operate on files of unlimited size. Therefore, to create a really huge program, you must still use the \$Include metastatement to indicate that other source files are to be merged in at compile time.

The absence of a link step, however, is like a "good news/bad news" joke. In this case, the bad news is that you can't pre-compile frequently used portions of BASIC code and put them in a user library. In some cases, too, it makes combining routines written in assembly language more difficult.

FULL 64K STRING SPACE While we're on the topic of memory management, yet another nice touch is Turbo's use of a full 64K for strings. At first glance, this may not seem so impressive an addition, since it is commonly believed that BASIC compilers have always allowed 64K for strings. However, in Turbo, the entire 64K block is available just for the string data.

In QB and BASCOM, by contrast, a single 64K segment is used to hold strings, their descriptors, regular numeric vari-

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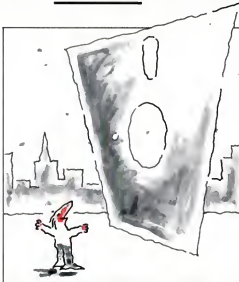
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■ PC LAB NOTES

ables, and static arrays, as well as the stack. Add to those all of the necessary system variables (the current foreground and background colors, the current Def Seg setting, etc.), and there's actually not much left over for strings. Indeed, merely dimensioning a string array to 2500 steals 10K just for the descriptors! But by keeping all string data in an entirely separate segment, Turbo BASIC gives you a full 64K to use.

■ For the most part, Turbo BASIC may be considered a superset of previous versions from Microsoft.

The only drawback to this method is that finding where a string lies in memory is more difficult. As we are about to see, creating an assembler routine to access strings in Turbo BASIC requires more steps than in QB2.

ASSEMBLER ROUTINES For the most part, Turbo BASIC may be considered a superset of previous versions from Microsoft. That is, nearly all of the original commands are identical, and only the new ones need to be learned. But Turbo's assembly language interface is radically different, as is the way passed parameters are handled. Where Microsoft's compilers provide two methods for invoking an assembler routine—Call and Call Absolute—Turbo provides three. Let's look at each in turn.

CALL ABSOLUTE This form of call has been included for compatibility with older compilers and the interpreter, but it is limited by its inability to pass anything but integer variables. The example in Figure 4 will clear a window on the display screen by calling on Interrupt 10h in the BIOS. As is typical for this type of call, the assembler code is loaded into an integer array, then its address is located and called.

The routine in Figure 4 does not happen to use any passed parameters, but if it did they would be accessed in the same way as in older versions of BASIC. Notice that this example uses the new VarSeg function, which returns the SEGMENT of a variable. Turbo BASIC is very flexible in its handling of variables and arrays, and VarSeg lets you obtain the total address with ease.

CALL INTERRUPT This second form of the Call command allows a Turbo BASIC program direct access to the various DOS and BIOS interrupts, and it is considerably easier to use than Call Absolute. The simplest interrupt to invoke is obvi-

ously Int 5, which is the PrtSc handler located in the PC's BIOS. As you can see, printing the screen from within a Turbo program is trivial:

Call Interrupt 5

Of course, Call Interrupt allows you to do much more than just dump the screen. The program shown in Figure 5 clears a portion of the display window and illustrates how easily this can be accomplished with Call Interrupt.

You'll notice that in order to properly access most interrupts, you must be able to preload the processor's registers with specific values. This is done with the Reg command. By being able to do this from

```
***** ClearW.Bas - clears a portion of the display

Defint A-Z : Dim Code(7)           'make room for code
Cls
For X = 1 To 24
  Print String$(80, Chr$(X+96)); 'fill w/test pattern
Next

CodeAddress = VarPtr(Code(0))      'address to call
Def Seg = VarSeg(Code(0))          'segment for address
For X = 0 To 13
  Read Byte$
  Poke CodeAddress + X, Val("&H" + Byte$)
Next

Call Absolute CodeAddress           'go do it

Data B9,1E,0A : ' Mov CX,0A1Eh - upper left corner in CX
Data BA,32,0F : ' Mov DX,0F32h - lower right corner in DX
Data B8,00,06 : ' Mov AX,0600h - service 6 to clear in AX
Data B7,07 : ' Mov BH,07 - put "normal" color in BH
Data CD,10 : ' Int 10h - call BIOS
Data CB : ' Ret - back to Turbo BASIC
```

Figure 4: Call Absolute can be used for small assembler routines.

```
***** ClearW2.Bas - clears a portion of the display

$Include "RegNames" 'allows calling reg's by name
Cls
For X = 1 To 24
  Print String$(80, Chr$(X+96)); 'fill w/test pattern
Next

Reg %CX, &H0A1E 'upper left corner - 10,30
Reg %DX, &H0F32 'lower right corner - 15,50
Reg %AX, &H0600 'service 6 to clear
Reg %BX, 7 'clear to normal color

Call Interrupt &H10
```

Figure 5: Call Interrupt is the easiest way to get to DOS and the BIOS.

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■ PC LAB NOTES

WHAT IS RECURSION?

By definition, a recursive program is one that may call itself while executing. Any number of programs appear to do this. For instance, the routine in Figure A strips leading spaces from a string by repeatedly looping to the same instructions. That is not really an example of recursion, however, because a parameter is not being passed and because it doesn't require temporary variable storage to be created with each iteration.

Recoding the example as in Figure B gets us a little closer, and it actually works, but it still isn't true recursion. Why? Because in a Static procedure, a single area of memory is set aside internally to hold the passed parameter. With each subsequent invocation, the new incoming variable is stored at the same physical memory address as the previous one. In this case, though, it doesn't really matter. Once the leading space has been removed, we don't care anymore what *X\$* used to be. But as we will see in a moment, the ability to retain the previous value of a variable is the all-important key to recursion.

Usually, variable addresses are established when a program is compiled. (For strings, it is the string descriptors that are allocated, and not the actual data.) But if a routine is to be truly recursive, it must be able to store its variables on some sort of stack. That way, new storage locations can be allocated on demand, without destroying any previous values. This is exactly what Turbo BASIC does.

The program shown in Figure C will evaluate a mathematical expression with parentheses nested to any level, and exploits Turbo BASIC's recursive capability. Though this program is relatively short, it still packs a lot of power. Ignoring the nesting capability for the moment, let's see what happens with simple expressions. Eval is called by passing an

■ If a routine is to be truly recursive, it must be able to store its variables on some sort of stack.

incoming string containing the formula to evaluate, and a numeric variable that is to receive the calculated result.

The program begins by examining each character in the incoming string, using Instr to compare it against a table of possible operators. If you entered "7 + 3" as the argument, then it would find the "+" in the third position. The operator number (in this case 1—the "+" is the first symbol in the table) will also be retained for use later. In passing, you should take notice of Turbo's new Exit For command, which allows leaving a

For/Next loop prematurely.

Next, prior to the addition, the string must be split into a left and right portion. Since Val conveniently stops at the first nonnumeric character, the Val of "7 + 3" will be 7. Finally, the right-hand part is extracted by taking the Val of the string just past the third character (where the "+" was found), and a branch is made to the code that adds.

Now let's consider the slightly more involved expression "7 * (3 + 2)". Since we've got a routine capable of evaluating a single formula, it makes sense to have it evaluate the next inner portion, as well. This is where the recursion comes in. Only two additional statements are required, and they merely check to see if another parenthesis is present beyond the current portion of the expression. If so, Eval calls itself, passing only the part of the string that is past the current operator. The key point to remember is that the partial evaluations that have been made thus far *must* be retained.

Bear in mind that while this routine will accommodate any level of nesting, no more than one operation may be requested at a time. That is, you could enter an expression such as "7 * (5 * 6)", but not "7 * 5 * 6". However, Val does ignore extra leading or trailing spaces, so they won't matter.

Now let's take a look at a recursive function definition. A classic, textbook example of recursion uses a program that computes a factorial. In case you're a bit rusty on your math, the factorial of a number is the product of all the whole numbers equal to or less than itself. That is, the factorial of 3 is $3 * 2 * 1$, which is 6, and the factorial of 4 is $4 * 3 * 2 * 1$, which is 24. While there certainly are other approaches you could use for factorials, the function definition and program in Figure D exemplify the recursive method.

Remember that when doing recursive functions or procedures, for each iteration some amount of data is placed on the

```
Strip:
If Left$(X$,1) = " " Then X$ = Mid$(X$,2) : Goto Strip
```

Figure A: Not all code that calls itself is necessarily recursive.

```
Sub Strip(X$) Static
If Left$(X$,1) <> " " Then Exit Sub
X$ = Mid$(X$,2)
Call Strip(X$)
End Sub
```

Figure B: A Static subprogram retains only one level of data storage.

PC's internal stack. This is how Turbo is able to remember the variables that have already been assigned. But if a function or subprogram is allowed to call itself unchecked repeatedly, the stack will eventually overflow. When this happens, if

you have not instructed Turbo BASIC to perform stack checking (one of its many options), your program will surely crash.

Traditionally, of course, BASIC programmers have been isolated from any of the messy details of the PC's stack and

other internal workings. Indeed, this is much of BASIC's appeal. But as is often the case, an increase in power brings with it an increased risk. Both Turbo BASIC and QuickBASIC offer the option of testing whether an illegal array element is being requested, for example. The idea here is that while you are creating and testing your programs, you will turn on this "bounds testing," at the expense of reduced execution speed. Once you are satisfied that the program operates correctly, it is then compiled for the fastest possible performance.

But how, specifically, can a program test for the amount of remaining stack

```

***** Eval.Bas - illustrates recursion to evaluate an expression
Sub Eval(InComing$, OutValue) Recursive
Local Operation, Place, L, R, X, Y      'most of these MUST be local variables
For X = 1 To Len(InComing$)            'search for the first operator
  Y = InStr("+-*/\^", Mid$(InComing$, X, 1))
  If Y Then
    Operation = Y                        'save the operation being requested
    Place = X                             'end where it is in the string
    Exit For                             'get out of the loop early
  End If
Next X
L = Val(InComing$)                      'first get the value of the left part
R = Val(Mid$(InComing$, Place + 1))      'and then the right part
Y = InStr(Place, InComing$, "(")         'see if there's another "(" further in
If Y Then                                'there is, evaluate a new value for R
  Call Eval(Mid$(InComing$, Y + 1), R)
On Operation Goto Add, Subtract, Multiply, Divide, Exponentiate, IntDivide
Add:
  OutValue = L + R : Exit Sub
Subtract:
  OutValue = L - R : Exit Sub
Multiply:
  OutValue = L * R : Exit Sub
Divide:
  OutValue = L / R : Exit Sub
Exponentiate:
  OutValue = L ^ R : Exit Sub
IntDivide:
  OutValue = L \ R
End Sub
Line Input "Enter an expression: ", X$
Call Eval(X$, V)
Print "That evaluates to" V

```

Figure C: A recursive function to evaluate formulas nested to any level.

```

Defdbl A-Z                               'dbl allows numbers as big as 170
Def FnFact(X)
  If X = 1 Then                           'we can't do any more,
    FnFact = 1                             'exit with a value of 1
  Else
    FnFact = X * FnFact(X - 1)             'here's the recursion
  End If
End Def
Input "Enter a number: ", F
Print "The factorial of" F "is" FnFact(F)

```

Figure D: Using a recursive function to compute factorials.

■ Traditionally, BASIC programmers have been isolated from any of the messy details of the PC's stack.

space? Though the stack-checking option will prevent a total crash, and the \$Stack metastatement lets you set aside however much space you'd like, it's not always obvious what that value should be. Recognizing this need, Borland has sensibly added an additional variant to its Fre() command.

Where Fre(0) returns the amount of available "near" memory, and Fre(1) tells the amount of "far" memory, Fre(-2) reports the remaining stack space. Thus, by including a program line that tests Fre(-2) within the recursive subprogram or function, you can easily determine how much stack space is available at any time. But don't try to shave it too close. Since DOS and the BIOS also use the stack for their own purposes, you should leave a few hundred extra bytes just to be safe. —Ethan Winer

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■ PC LAB NOTES

within BASIC, that much less effort is required in assembly language. In addition, when the called program finishes, the setting of the PC's registers may be examined as well. Each of Turbo BASIC's registers is designated by a number, as shown in the listing below:

```
Flags = 0
AX = 1
BX = 2
CX = 3
DX = 4
SI = 5
DI = 6
BP = 7
DS = 8
ES = 9
```

Trying to remember these register numbers would be a real pain in the neck, but this points up yet another good use for Turbo's named constants. If you create an \$Include file like the one shown in Figure 6, you'll never have to deal with the problem at all.

Another good use for Call Interrupt is to access the large number of available DOS services. The program in Figure 7 illustrates both getting and setting the current default drive through DOS interrupt 21h. After setting the new drive, the program asks DOS to report the current drive, just to make sure that the change really took place. To do all this in pure assembly language programming would require considerably more effort, as you'll see in a moment.

In fact, DOS and BIOS services have become so easy to access that, unless you're a total beginner at BASIC, there's no good reason to be timid about attempting it. All the information you could ever need is contained in Peter Norton's excellent *Programmer's Guide to the IBM PC* (Microsoft Press).

CALLING INLINE ROUTINES When an assembly program must do more than merely access the system interrupts, the Inline method of coding is preferred. An Inline procedure is exactly that—a series of code bytes that are put into a subprogram sequentially and then executed when the subprogram is called. This third form of Call is the most powerful available in Turbo BASIC, and it lets an assembly lan-

```
***** RegNames.Bas - include file
```

```
%FL = 0 : %AX = 1 : %BX = 2 : %CX = 3 : %DX = 4
%SI = 5 : %DI = 6 : %BP = 7 : %DS = 8 : %ES = 9
```

Figure 6: Turbo's named constants simplify using the 8088's registers.

```
***** GetSet.Bas - getting and setting the default drive
$Include "RegNames" 'allows calling reg's by name

Line Input "New Drive: ", Drive$ 'ask for the new drive letter
Drive = Asc(UCase$(Drive$))-65 'convert to capital letter,
                                'and make "A"=0, "B"=1, etc.
Reg %AX, %HSE00 'set AH for Set Drive service
Reg %DX, Drive 'set DL to specified drive
Call Interrupt %H21 'call DOS to do it

Reg %AX, %H1000 'set AH for Get Drive service
Call Interrupt %H21 'ask DOS for current drive

NewDrive = Reg(%AX) And %HFF 'drive is now in AX - clear
                              ' high part (AH) using And
If NewDrive <> Drive Then 'if the new drive isn't what
    Print "Invalid drive!" ' was specified, then error
Else
    Print "The default drive is now " Chr$(NewDrive + 65)
End If
```

Figure 7: The Reg function lets you access the 8088 registers directly.

```
Sub GetDrive Inline
$Inline %H55, %H89, %HE5, %HE8, %H46, %H08, %H8B
$Inline %H76, %H06, %HB4, %H19, %HCD, %H21, %H98
$Inline %H04, %H41, %H26, %H89, %H04, %H5D
End Sub
```

Figure 8: Assembly language code may be entered in a program directly.

```
***** GetDrive.Asm - Retrieves the default drive
;Syntax Call GetDrive(Drive%)
Print "The current drive is " Chr$(Drive%)

Code Segment Byte
Assume CS:Code
Begin: Push BP
      Mov BP, SP
      Mov ES, [BP+08] ;save BP
      Mov SI, [BP+06] ;put stack address into BP
      Mov AH, 19h ;get Drive's segment into ES
      Int 21h ;now put Drive's address into SI
      Cbw ;get default drive service
      Add AL, 65 ;call DOS
      Mov ES, [SI], AX ;throw away AH
      Pop BP ;adjust so 0="A", 1="B", etc.
      EndS ;assign Drive% = AL using ES
Code Begin
```

Figure 9: The MASM source for an Inline DOS function call.

■ PC LAB NOTES

TURBO BASIC VS. QB2: TESTING THE COMPILERS

When people found out I was preparing an article on Turbo BASIC, one of the first things they'd ask is how fast it is compared to QuickBASIC. For many, speed matters: all else is irrelevant. Well, I'm pleased to report that Turbo BASIC lives up to its name—especially if you have an 8087. However, evaluating something as complex as a language compiler is not simple, so I'd like to share some of the factors that helped shape the benchmark tests whose results are shown in Figure E.

One of the most common techniques for evaluating a language is to see how quickly it can run the Sieve of Eratosthenes and the Prime Number Generator (two popular benchmark programs). While these certainly are valid tests, they are purely mathematical and completely ignore many of BASIC's other important features. Indeed, to ignore string handling, file I/O, and graphics is to ignore BASIC. Further, the people who write compilers aren't stupid; they know that these tests will be used, so many compilers are optimized for them.

While I do a lot of programming in BASIC, the only time in my entire life that I have written a purely "math" type program was for the "What is Recursion?" sidebar in this article. I'm sorry, but evaluating formulas and factorials simply doesn't enter into my daily routine. For that matter, I don't use graphics often enough to design a meaningful benchmark test either, so unfortunately you won't find that included here. Then what tests did I perform?

Obviously some calculations were needed. And since Turbo uses an 8087 if one is present, the timings had to be presented both ways to be fair to QuickBASIC. A number of string operations were also included, as well as both sequential and random file accesses.

All of my tests were performed on a standard IBM PC running DOS 3.1, with a freshly initialized RAMdisk used for each of the I/O tests. (I used the DOS VDisk program, and had Buffers=20

and Files=20 statements in the CONFIG.SYS file.) I am always amused when I see benchmark tests done using floppy disks—not only because the slowness of a floppy could easily overshadow the speed of the program, but also because DOS will retry a disk operation up to five times without telling you. No other programs were resident in memory, since many TSRs intercept the timer interrupt, which could affect the results.

It would have been tempting to use Turbo's MTimer for the tests, but there is no equivalent in QuickBASIC. Instead, I used the normal Timer function immediately before and after each test. To minimize errors, the math and disk tests were performed 2,000 times each, and the string tests 1,000 times. I had intended to use numeric arrays with 4,000 elements,

and a 2,000-element string array. In fact, I had completed the timings for Turbo BASIC that way, before discovering that QB2 runs out of memory.

QuickBASIC has no built-in function to convert a string to uppercase (as in Turbo BASIC); you should bear that in mind in evaluating my test results. On the other hand, Turbo BASIC calculations are performed to an accuracy of 80 bits, so without an 8087 they are quite slow.

These are my math tests:

1. Fill two Static arrays and two Dynamic arrays—one each single precision and double precision—with the constant value 1.001.
2. Add all of the elements in each array.
3. Multiply all elements in each array.
4. Calculate PI 2,000 times using $PI\# = 4\# * \text{Atn}(1\#)$.

Test Performed	QB2	TB w/87	TB w/o 87
Compile time:	9.75	5.50	7.00
Fill single prec. Static array:	0.17	0.16	1.92
Fill double prec. Static array:	0.16	0.22	2.09
Fill single prec. Dynamic array:	0.33	0.16	1.98
Fill double prec. Dynamic array:	0.33	0.22	2.09
Add single prec. Static array:	0.66	0.22	3.46
Add double prec. Static array:	0.82	0.27	3.73
Add single prec. Dynamic array:	0.88	0.27	3.58
Add double prec. Dynamic array:	1.04	0.27	3.79
Mult single prec. Static array:	0.83	0.22	4.45
Mult double prec. Static array:	1.54	0.27	4.72
Mult single prec. Dynamic array:	0.98	0.27	4.50
Mult double prec. Dynamic array:	1.76	0.27	4.83
Sort single prec. Static array:	8.13	4.61	34.38
Sort double prec. Static array:	9.34	5.22	36.09
Sort single prec. Dynamic array:	8.02	4.61	34.38
Sort double prec. Dynamic array:	9.22	5.16	36.08
Calculate PI:	29.88	0.71	27.41
Create random names:	20.87	13.24	91.73
Normal name search:	0.32	0.60	0.66
Capitalized name search:	21.04	1.43	1.48
Sort string array:	3.98	6.54	6.54
Swap first/last names:	2.74	2.86	2.86
Write names to sequential file:	5.54	5.38	5.38
Read names from sequential file:	5.44	2.47	2.47
Write to random access file:	12.74	12.30	12.30
Read from random access file:	18.44	9.45	9.50

Figure E: Benchmark test comparisons between Turbo BASIC and QuickBASIC.



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■ PC LAB NOTES

cess to the array descriptor in the assembler program, a call such as

```
Call Sort(Array$(First), ArraySize)
```

could be simplified to

```
Call Sort(Array$())
```

TURBO'S STRINGS Before we look at some actual examples of inline assembler code, a few words about strings are in order. Compared to string descriptors in QB2 and BASCOM, the length and address words in Turbo are reversed. That is, the address bytes come *before* the length bytes. There's nothing wrong with this, of course, unless you don't know about it! Also unlike QB2, as new strings are assigned, they grow toward higher memory addresses.

As you'd probably expect, string descriptors for arrays are always stored at contiguous memory addresses. This makes it easier to locate the various elements; remember, though, that the actual string data is kept in its own separate segment. You can find that segment within Turbo's default data segment at absolute address DS:0000.

One warning when dealing with strings: the length word may have its high bit set. If you are counting on that length prior to moving a string to somewhere else in memory, be sure to And the bit off after getting it. Otherwise, you'll move a *lot* more bytes than intended and probably crash the program.

Inline assembler routines may be added to your program in either of two ways. As in Turbo Pascal, the hex bytes may be entered directly, separated by commas, as shown in Figure 8. However, a much slicker method lets you specify a .COM program in a manner similar to that for regular BASIC \$Include files.

```
Sub GetDrive Inline
$Inline "GetDrive.Com"
End Sub
```

The overwhelming advantage of this latter approach is that you won't need to enter the bytes manually. But regardless of which method you choose, you'll still have to create the assembler code in the first place. Since linking is not required in Turbo, using DEBUG rather than MASM to

create the programs is perfectly feasible, though with large programs, MASM's ability to use labels will simplify your task.

Having seen how to ask DOS to report the current drive using Call Interrupt, let's now do the same thing using Inline. The bytes shown in Figure 8 are derived from just such a routine: the assembly listing in Figure 9 spells it out.

In this routine I chose to use the ES register instead of the usual DS. You could use DS, of course, but this would require first saving it, obtaining the address for Drive%, and then restoring it before re-

turning to BASIC. Aside from the extra step involved to get the segment for Drive%, this routine is straightforward. Getting access to strings is a bit tougher.

Rather than use a numeric variable to specify which drive, it's easier for the BASIC programmer to use a regular drive letter. The routine in Figure 10 does exactly this, and it accepts either an upper- or lowercase character. As you can see, a number of extra steps are required to get at Drive\$.

One additional item worth mentioning is the extra offset that is needed to obtain these addresses through the BP register.

THE MAKING OF TURBO BASIC: DESIGNED FOR SPEED

When I think of a large company like Borland working on a project such as Turbo BASIC, I envision teams of faceless programmers at work in little cubicles. Since Turbo is written entirely in assembly language, it's not hard to imagine at least two or three people designing the floating-point math library while another group is discussing ways to improve the code generation. Perhaps, too, there's a project manager somewhere making last-minute cosmetic changes.

An amazing fact: Turbo BASIC was almost entirely conceived and coded by one person—Bob Zale. The user interface and pull-down menus have their roots in Turbo Prolog, and were written by Mike Weisert and Pat Grever. But it was Bob Zale who thought up and implemented all the new commands and features that have been the focus of these articles.

In telephone conversations with Bob, I've learned quite a bit about the design of Turbo BASIC—and about compilers in general. Some interesting trivia also emerged, such as that the assembly language source listing requires a case and a third of paper. But many very hard decisions go into a project like this. Among the most difficult was whether to abandon Microsoft's floating-point format and use the IEEE standard instead. And while it's great to emulate the 8087's accuracy even if one is not present, as the

benchmark tests show, this comes at the expense of computation speed.

A myriad of programming details needed to be worked out too, many of which are utterly transparent to those using the product. For instance, whenever Turbo's micro timer is started, the PC's regular timer interrupt must also be synchronized, to prevent a timer tick from coming along and disrupting the count. But the most fascinating things I learned from Bob were the variety of ways a compiler can optimize the code that it creates.

In the section on assembly language, I had originally intended to show a routine that would initialize an integer array to any arbitrary value. The idea was to get the value and starting address of the array and then use the 8088's speedy REP MOVSW instructions to quickly fill each element. But as it turns out, this is exactly what Turbo BASIC already does. If you have something like this in your program,

```
For X = 1 To Size
  Array$(X) = Value%
Next
```

the compiler recognizes what you're trying to do, and creates code to fill the array using MOVSW in one pass. Another area where Turbo's code is optimized is in the evaluation of the logical operators And and Or.

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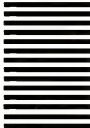
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This really has nothing to do with Turbo specifically, but it's easy to get used to having the first parameter always be at BP+06, the second at BP+08, etc. In this case, the addresses begin at BP+08 because DS was also pushed onto the stack by the program.

Speaking of BP, beware of using it as a general-purpose index register. This is tempting to do when the other registers are already in use, but remember that BP defaults to using the STACK segment. In QuickBASIC and BASCOM the stack and data segments are one and the same, so

you can use either register freely. But since Turbo BASIC keeps its stack and data separate, you must add a segment override to use BP with data kept in DS (or ES).

```
Mov SI, DS:[BP+14]
```

Extra steps will also be required if you intend to maintain variables local to an assembly language routine. Since inline programs are essentially in a .COM format, you can't just define a separate data segment and keep your work variables there.

Two possible solutions come to mind. One is to have your program jump over an area that has been set aside using Call, and then pop the address from the stack:

```
Begin: Call Start
Data   DB 10 Dup (?)
Start: Pop BX
```

When the program arrives at location Start, BX will be holding the base address of the data. The various bytes can then be referenced using [BX], [BX+3], etc. Another approach would be to set aside space on the system stack.

```
Begin: Push BP
      Sub SP,10
      Mov BP,SP
      .
      .
      Add SP,10
      Pop BP
```

Now your variables can be accessed using [BP], [BP+3], etc. Just be absolutely certain to restore the stack pointer as shown above, before returning to Turbo BASIC.

ENDMEM AND MEMSET The final commands new to Turbo's assembly interface are EndMem and MemSet, which report and set the last available memory address in the system, respectively. These are generally intended to be used as a pair, for example, to reserve room for an assembly language subroutine. Another possible use would be for storing help screens or additional graphics pages. In fact, you could even install a custom interrupt handler in that space, and then access the routine with Call Interrupt. Unlike code kept in an integer array, you are guaranteed that its location will never move.

Storing a routine as an interrupt in high memory might make sense in some situations, as when the routine provides more than one service. Since Call Interrupt lets you preload the registers from within BASIC, that could be one way to indicate which service is being requested.

To do this, first set aside sufficient space, using EndMem and MemSet. Next, place the starting address of that space in

■ One warning when dealing with strings: the length word may have its high bit set.

the interrupt vector table contained in low memory. This may be done by poking the address and segment directly or by calling on DOS service 25 to do it for you. Of course, you can't just go around messing with any old interrupt—especially if you're not sure which ones are available.

The PC has several interrupts that have been reserved for your use. For example, interrupts 60h through 67h are defined in the IBM PC Technical Reference manual as being available. You could probably use the cassette interrupts—54h through 57h—as well. The only thing to watch out for is that other, memory-resident programs may be using the same ones. In this case, what's good for the goose might be devastating for the gander.

SUMMING UP There can be no doubt that Borland's Turbo BASIC is going to be stiff competition for Microsoft (and others). Even though it lacks QuickBASIC's user libraries and sophisticated step and trace capabilities, Turbo BASIC more than compensates with a delightful editor and a substantial number of extensions to the language. Perhaps most exciting of all, however, is the anticipation of even better versions to come.

Ethan Winer, an independent consultant, is the head of Crescent Software in East Norwalk, Connecticut.

If X < 1 And Y > 22 Then . .

When such a test is used in a QuickBASIC program, QB2 evaluates both sides of the And before deciding if the expression is true. But Turbo BASIC first checks to see if X is less than 1, and, if not, gives up immediately. After all, if it isn't, then why bother testing Y? (By the way, this technique is called "short circuit expression evaluation.")

Yet another interesting aspect of Turbo's optimization is the way the floating-point library routines are self-modifying. While playing around to see how long it took to compute a variety of 8087 instructions, I discovered what I thought was a bug in MTimer.

The first test calculated a Sin and took about 600 microseconds. But each subsequent run of the program took only half that time. When I reported the "bug," Bob explained that if a coprocessor is present, the library routines are modified on the fly into the equivalent 8087 instructions.

Further, the 8087 is executed in the background whenever possible. Where many compilers will get the coprocessor started and then wait around for it to finish, Turbo BASIC goes off and does something else in the meantime if possible. You measure such details as speed. You perceive them as beauty.

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```
MASM REPEATS;  
LINK REPEATS;  
EXE2BIN REPEATS REPEATS.COM
```

REPEATS at a Glance

REPEATS searches through all the subdirectories on a drive and produces a listing of all files (and the directory in which they are located) that have the same filenames. Syntax:

```
REPEATS [d:][/P]
```

Operation: The drive specifier (d:) is not required if the current drive is to be searched. If used (as, for example, to

check a directory-structured floppy disk), the colon must be included in the drive specification. The optional /P printer switch will echo the output both to a printer and to the screen. In addition, standard DOS redirection (>) may be used to store the output to a filename.

If insufficient memory is available the program terminates with an error message to that effect. Ctrl-Break will terminate the program manually.

will put a list of all duplicates into a file called REPEATS.LST, which you can then load into your word processor. (If you redirect the output to a file there will be no echo to the screen, but you'll know when REPEATS has completed its job by the return of the DOS prompt.)

HOW REPEATS WORKS REPEATS begins by saving the current drive and directory. Obviously, in its search for duplicates, REPEATS will be constantly changing directories, but when it has done its work, it's desirable for it to restore you to DOS where you began. (Many utilities don't do this, so unless you're using a

"ps" prompt to remind you which directory is current, your next disk access may not produce the results you intended. That, in turn, can contribute to the problem of unintended file littering.)

The command line parsing is relatively simple. If a colon is found, the preceding character is assumed to be a drive request, and if a "/" is found, the following character is assumed to be a switch character. If a drive request is found, the default drive is changed, and if a printer switch is found, a flag is set so REPEATS will know it should echo all output to the printer.

With large hard drives (anything over 10 megabytes), REPEATS will have to

deal with more than 64K of data. Most programs published in this column stay in the one-segment boundary, 64K. It's just plain easier to program within the one-segment structure of .COM files. My original version of REPEATS tried to do all its work in one segment, via repetitive DOS calls, letting DOS do all the work of finding duplicates. This approach made REPEATS painfully slow. To speed things up, the solution was to read all the directory and filename information into memory at once, and then compare one filename against the next for duplicates.

This resulted in data storage that crossed the 64K boundary. The filename information—name, size, date, and time—takes up 21 bytes. An average 30-megabyte hard disk might have 2,800 files, which means 58,000 bytes for the filenames alone. When the directory names are added (they require 64 bytes per name), the segment boundary is quickly outgrown.

Crossing the segment boundary requires REPEATS to do much more memory management. When DOS loads a .COM program, the stack pointer is placed at the end of the segment. REPEATS uses the memory from the end of code on for its workspace. This means the stack could be written over, so REPEATS first moves the stack pointer to the end of code plus 200H. This leaves a stack size of 512 bytes, which is more than enough room. REPEATS then uses function call 4AH to ask DOS to allocate 64K of memory.

Handling the filename information for even a 10-megabyte hard disk will require a minimum of 64K of working memory, though it's assumed that the directory information will also fit into this 64K. If DOS returns with less than 64K available, REPEATS does not even attempt to do its work, exiting with a "Not enough memory" message. The additional memory required by larger disks will be dealt with in a moment.

GETTING STARTED REPEATS's first task is to read in all the directory names. The program uses a one-dimensional array indexing technique to keep track of its place in its search for these directory names. REPEATS systematically moves up and down all the branches of the direc-

(Figure 1 continues)

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[illegible][illegible]

(Figure 1 ends)

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tory tree, storing the name of each directory for use in the duplicate-file searching routine.

Here's how the technique works. Suppose we have two subdirectories, SUBDIR1 and SUBDIR2, branching from the root. That gives us a two-tiered directory tree. Initially, we want the first subdirectory entry of each tier, so the two subscripts of the indexing array are set to one. Using the BASIC conventions, these would be F(1)=1 and F(2)=1. When we find the first subdirectory in the root, we will increase the root index (F(1)=2). We can now safely change to SUBDIR1 and search for any subdirectories branching higher in the tree. If no subdirectories are found in SUBDIR1, we will return to the root directory in search of the next subdirectory. To recall our position in the root, all that has to be done is look at the subscripts of that level. We now find that F(1)=2 so we will look for the second subdirectory, SUBDIR2. This technique will work with the most complicated directory tree. (For a more detailed description of how the array is used to keep track of the entry number of the current directory, see the discussion in my SEARCH program, *PC Magazine*, Volume 6 Number 4.)

Once the names of all the directories have been found and stored, and before all the filenames are read in, it's time for more memory management. The end of directory storage will be the start of filename storage. REPEATS at this point again asks DOS to modify the allocated memory block to end with the directory name storage, thus returning any excess from the previously reserved 64K back to the system pool.

Next, a block of 0FFFFH paragraphs (1 megabyte) is requested, via function call 48H. This will obviously fail, but when it does, DOS returns with the available memory in the BX register. This tells REPEATS how much working space it has for filenames. The number of returned paragraphs (16-byte blocks) of available memory is added to the segment address for the end-of-directory storage, and the total is stored in a variable, END_OF_SPACE, for future reference.

Now, starting with the root directory, REPEATS finds all the filenames in each directory. DOS provides two complemen-

tary calls, find first matching (4EH) and find next matching (4FH), to serve this purpose. On issuing a 4EH function call, the value of CX determines which attribute DOS will use in searching for a matching filename. In the directory search used in the routine above, CX was equal to 10H, the attribute of directories. Here the value of CX is 6H, the attribute of normal files.

DOS returns the information to the DTA (disk transfer address), a memory location at the end of code, which was previously assigned by REPEATS. All the pertinent returned information (filename, time, date, and size) is then stored in a 32-byte record. (A record is a reserved memory space of given length; the reason for choosing 32 bytes will be explained shortly.) The first entry in the record is a word with the directory number. REPEATS indexes the directories by simply assigning a number, starting from one (the root directory) and incrementing with each subdirectory. The next record entries are two words that contain the file's time and date of creation, and two words to hold the file size.

This is followed by the filename, which is stored in the same format you get with the DOS DIR command. Filenames with less than eight characters before the period are padded with spaces, and the period is replaced with a space. Finally a byte of zero is tacked on to mark the end of the record. REPEATS looks for a zero as the end of strings in all its display output.

CROSSING THE LINE This makes a total of 24 bytes. So why the 32-byte record? In order to cross the 64K boundary limited by the source (SI) and destination (DI) pointers, REPEATS changes the data segment (DS) and extra segment (ES) registers. Usually, when storage is done using the string instructions (MOVSB, for example), the segment registers are left alone and the SI and DI registers are used as pointers for the next record. This sets a limit 0FFFFH (64K). Of course, when the end of the segment is reached, the segment register could be bumped to the next 64K segment and the pointers turned back to zero. However, it's much easier to change

```

100 REM -- BASIC PROGRAM TO CREATE REPEATS.COM
110 OPEN "REPEATS.COM" AS #1 LEN = 1
120 FIELD #1,1 AS A$
130 CHECKSUM = 0
140 FOR I = 1 TO 157
150   LINESUM = 0
160   FOR J = 1 TO 8
170     READ BYTE
180     CHECKSUM = CHECKSUM + BYTE
190     LINESUM = LINESUM + BYTE
200     IF (BYTE < 256) THEN LEFT A$ = CHR$(BYTE)
210     PUT #1
220   NEXT J
230   READ LINECHECK
240   IF LINECHECK <> LINESUM THEN PRINT "Error in Line"; 280 + 10 * I
250 NEXT I
260 CLOSE
270 IF CHECKSUM = 1268291 THEN PRINT "Successful Completion!": END
280 PRINT "COM file is not valid!": END
290 DATA 233, 32, 1, 67, 111, 112, 121, 114, 791
300 DATA 183, 183, 184, 116, 32, 49, 57, 56, 422
310 DATA 33, 32, 38, 185, 182, 182, 45, 68, 599
320 DATA 97, 118, 185, 115, 32, 88, 117, 98, 762
330 DATA 188, 185, 115, 184, 185, 118, 183, 32, 782
340 DATA 67, 111, 46, 26, 77, 185, 99, 184, 635
350 DATA 97, 181, 188, 32, 74, 46, 32, 77, 567
360 DATA 181, 182, 182, 111, 114, 188, 42, 46, 718
370 DATA 42, 8, 46, 46, 8, 92, 8, 8, 226
380 DATA 8, 8, 8, 8, 8, 8, 8, 8, 8
390 DATA 8, 8, 8, 8, 8, 8, 8, 8, 8
400 DATA 83, 181, 97, 114, 99, 184, 185, 118, 813
410 DATA 183, 32, 8, 32, 182, 111, 114, 32, 526
420 DATA 188, 117, 112, 188, 185, 99, 97, 116, 854
430 DATA 181, 32, 182, 185, 188, 181, 32, 118, 681
440 DATA 97, 188, 181, 115, 46, 13, 18, 75, 567
450 DATA 111, 97, 188, 185, 118, 183, 32, 188, 758
460 DATA 185, 114, 181, 99, 116, 111, 114, 185, 865
470 DATA 182, 115, 46, 46, 112, 97, 111, 116, 679

```

(continues)

Figure 2: A BASIC program that will automatically create REPEATS.COM.

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the segment register for each record.

If the SI register is kept the same, incrementing the segment register (DI) by one changes the indexing by 16 bytes. (Remember, a segment register applies to 16-byte paragraphs.) For example, if DS = 1000H and SI = 10(16d), the absolute address will be 10010H. This is the same as DS = 1001H and SI = 0, as shown below:

```
DS = 1000H paragraphs = 10000H bytes
    + SI = 10H bytes
    -----
    10010H bytes
or
DS = 1001H paragraphs + 10010H bytes
    + SI = 0H bytes
    -----
    10010H bytes
```

We needed 24 bytes for each record, so REPEATS adds two to the segment registers for each record, making a total of 32 bytes. In a sense this "wastes" 8 bytes between each record (32-24), but it makes it easy for REPEATS to keep track of how much memory is left after storing each record. All the program needs to do is compare the segment register with the variable END_OF_SPACE, the segment address of the end of memory, that was saved above. If REPEATS reaches this wall before reading all the filenames, it exits with the out-of-memory message.

Once all the filenames are read, REPEATS compares the first filename with all the rest. If a duplicate is found it is displayed along with its directory name. Next the second filename is checked with all those above it in the list. The first filename doesn't need to be checked again—if it was a duplicate it would have been found on the first pass. Each subsequent pass will have one less filename to check for a match. This is repeated until the last entry is the source file and there are no others to compare with. This is REPEATS's cue that its work is done and, after prompting the user with the appropriate message, control is returned to DOS.

To avoid repetitive display, when a match is found, REPEATS changes the directory number entry (the first word in the record) to 0FFFFH. In subsequent comparisons, REPEATS skips the filename if the record has a directory number of 0FFFFH. This is a simple matter of checking to see if the first word of the record is the same. This directory index is also used

480 DATA	105,	101,	110,	99,	101,	32,	112,	100,	760
490 DATA	101,	97,	110,	105,	101,	10,	76,	531	
500 DATA	111,	100,	105,	110,	101,	32,	102,	760	
510 DATA	105,	100,	101,	32,	110,	97,	109,	101,	763
520 DATA	115,	46,	46,	46,	0,	13,	10,	32,	300
530 DATA	32,	32,	32,	32,	32,	32,	32,	60,	292
540 DATA	105,	114,	101,	99,	116,	111,	114,	121,	801
550 DATA	32,	0,	7,	13,	10,	70,	111,	32,	203
560 DATA	100,	117,	112,	100,	105,	99,	97,	116,	854
570 DATA	101,	115,	32,	102,	111,	117,	110,	100,	708
580 DATA	46,	13,	10,	0,	7,	13,	10,	13,	112
590 DATA	10,	03,	101,	97,	114,	99,	104,	32,	640
600 DATA	115,	117,	99,	101,	115,	115,	102,	117,	801
610 DATA	100,	100,	121,	32,	99,	111,	109,	112,	800
620 DATA	100,	101,	116,	101,	100,	46,	13,	10,	595
630 DATA	0,	70,	111,	116,	32,	101,	110,	111,	659
640 DATA	117,	103,	104,	32,	109,	101,	109,	111,	706
650 DATA	114,	121,	0,	252,	107,	0,	16,	100,	870
660 DATA	74,	205,	33,	190,	17,	2,	115,	3,	639
670 DATA	235,	25,	2,	100,	220,	7,	100,	000	
680 DATA	205,	33,	162,	73,	1,	130,	14,	120,	754
690 DATA	0,	120,	249,	0,	116,	47,	50,	237,	827
700 DATA	190,	120,	0,	120,	60,	50,	117,	13,	695
710 DATA	130,	04,	255,	120,	226,	95,	120,	234,	1200
720 DATA	65,	100,	14,	205,	33,	120,	60,	47,	732
730 DATA	117,	16,	130,	04,	1,	120,	226,	95,	805
740 DATA	120,	250,	00,	117,	0,	190,	6,	02,	006
750 DATA	1,	1,	70,	226,	214,	190,	6,	130,	854
760 DATA	0,	92,	190,	130,	0,	232,	211,	1,	801
770 DATA	190,	06,	1,	232,	20,	2,	100,	25,	736
780 DATA	205,	33,	130,	200,	120,	194,	65,	232,	1203
790 DATA	242,	1,	170,	50,	232,	237,	190,	1139	
800 DATA	99,	1,	232,	253,	1,	253,	176,	1,	1015
810 DATA	105,	100,	0,	191,	30,	0,	243,	170,	935
820 DATA	106,	229,	7,	232,	177,	1,	190,	240,	1270
830 DATA	0,	100,	30,	0,	106,	69,	1,	100,	679
840 DATA	11,	205,	33,	232,	156,	1,	255,	6,	099
850 DATA	74,	1,	190,	60,	255,	92,	232,	130,	1000
860 DATA	1,	131,	190,	65,	131,	6,	71,	1,	604
870 DATA	65,	235,	10,	120,	253,	30,	0,	116,	062
880 DATA	67,	106,	66,	1,	232,	123,	1,	62,	730
890 DATA	190,	70,	0,	1,	77,	50,	219,	106,	801
900 DATA	62,	1,	105,	16,	0,	232,	116,	1,	613
910 DATA	114,	225,	120,	62,	250,	7,	16,	117,	910
920 DATA	20,	120,	62,	3,	0,	46,	116,	21,	412
930 DATA	204,	195,	62,	50,	94,	0,	117,	13,	793
940 DATA	62,	254,	70,	0,	106,	3,	0,	232,	815
950 DATA	72,	1,	69,	235,	162,	232,	81,	1,	053
960 DATA	114,	105,	235,	214,	131,	62,	74,	1,	1016
970 DATA	1,	117,	3,	233,	9,	1,	131,	190,	693
980 DATA	15,	177,	4,	211,	230,	130,	220,	100,	1100
990 DATA	74,	205,	33,	107,	255,	255,	100,	72,	1261
1000 DATA	205,	33,	100,	74,	205,	33,	140,	193,	1063
1010 DATA	3,	206,	142,	193,	137,	14,	70,	1,	774
1020 DATA	3,	217,	137,	30,	00,	1,	190,	167,	825
1030 DATA	1,	232,	70,	1,	199,	6,	71,	1,	561
1040 DATA	247,	6,	51,	237,	100,	11,	205,	33,	972
1050 DATA	69,	59,	46,	74,	1,	119,	102,	139,	609
1060 DATA	22,	71,	1,	232,	236,	0,	131,	6,	699
1070 DATA	71,	1,	65,	106,	62,	1,	105,	6,	577
1080 DATA	0,	232,	232,	0,	115,	26,	235,	220,	1060
1090 DATA	140,	192,	5,	2,	0,	142,	192,	190,	063
1100 DATA	17,	2,	50,	6,	00,	1,	11,	7,	202
1110 DATA	233,	156,	0,	232,	211,	0,	114,	196,	1142
1120 DATA	255,	6,	76,	1,	190,	251,	7,	51,	837
1130 DATA	255,	139,	197,	171,	105,	4,	0,	243,	1194
1140 DATA	165,	105,	12,	0,	172,	60,	0,	116,	710
1150 DATA	19,	60,	46,	117,	12,	131,	233,	3,	621
1160 DATA	176,	32,	240,	1370,	131,	393,	3,	235,	1103
1170 DATA	235,	170,	226,	232,	176,	32,	243,	170,	1404
1180 DATA	176,	0,	170,	235,	179,	30,	199,	6,	1003
1190 DATA	0,	0,	255,	255,	190,	06,	1,	232,	1019
1200 DATA	192,	0,	161,	70,	1,	235,	15,	100,	062
1210 DATA	11,	205,	33,	46,	190,	6,	05,	1,	505
1220 DATA	0,	140,	10,	0,	0,	0,	0,	216,	507
1230 DATA	142,	192,	131,	62,	32,	0,	255,	116,	930
1240 DATA	54,	30,	139,	46,	0,	0,	131,	253,	661
1250 DATA	0,	116,	220,	140,	216,	5,	2,	0,	699
1260 DATA	142,	216,	190,	0,	0,	179,	61,	255,	1037

(Figure 2 continues)

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1270 DATA	255,	116,	284,	59,	197,	116,	236,	190,	1373
1280 DATA	18,	8,	191,	18,	0,	185,	6,	0,	402
1290 DATA	243,	167,	117,	223,	232,	121,	0,	199,	1302
1300 DATA	6,	0,	0,	0,	0,	235,	212,	14,	467
1310 DATA	31,	186,	138,	0,	232,	35,	0,	138,	768
1320 DATA	22,	73,	1,	189,	14,	205,	31,	190,	718
1330 DATA	236,	1,	128,	62,	83,	1,	1,	116,	628
1340 DATA	3,	190,	218,	1,	14,	31,	232,	73,	754
1350 DATA	8,	205,	32,	178,	0,	188,	71,	285,	871
1360 DATA	33,	195,	188,	59,	285,	33,	195,	188,	1988
1370 DATA	26,	205,	33,	195,	188,	78,	205,	33,	955
1380 DATA	195,	188,	79,	205,	33,	195,	178,	33,	1876
1390 DATA	232,	17,	0,	178,	18,	232,	12,	0,	681
1400 DATA	195,	178,	32,	232,	6,	0,	178,	32,	853
1410 DATA	232,	1,	0,	195,	46,	128,	62,	82,	746
1420 DATA	1,	1,	117,	4,	188,	5,	205,	33,	546
1430 DATA	188,	2,	265,	33,	195,	138,	208,	232,	1193
1440 DATA	234,	255,	172,	68,	0,	117,	246,	195,	1279
1450 DATA	38,	46,	198,	6,	03,	1,	24,	46,	411
1460 DATA	128,	62,	85,	1,	1,	116,	31,	232,	656
1470 DATA	188,	255,	185,	39,	0,	178,	45,	232,	1122
1480 DATA	282,	255,	226,	249,	46,	158,	6,	85,	1267
1490 DATA	1,	1,	38,	161,	0,	0,	232,	18,	451
1500 DATA	0,	148,	198,	232,	42,	0,	161,	0,	773
1510 DATA	0,	232,	7,	0,	148,	222,	232,	31,	864
1520 DATA	0,	31,	195,	72,	179,	65,	246,	227,	1818
1530 DATA	139,	248,	38,	14,	31,	198,	189,	1,	842
1540 DATA	232,	175,	255,	198,	247,	0,	3,	247,	1387
1550 DATA	232,	167,	255,	232,	128,	255,	31,	195,	1487
1560 DATA	38,	142,	222,	198,	18,	0,	232,	153,	979
1570 DATA	255,	139,	22,	0,	0,	161,	6,	0,	591
1580 DATA	185,	16,	39,	247,	241,	82,	139,	216,	1165
1590 DATA	232,	141,	0,	91,	232,	149,	0,	232,	1877
1600 DATA	95,	255,	139,	54,	4,	0,	139,	222,	988
1610 DATA	177,	5,	211,	283,	129,	227,	15,	0,	967
1620 DATA	46,	198,	6,	84,	1,	0,	232,	135,	782
1630 DATA	0,	178,	45,	232,	78,	255,	139,	222,	1148
1640 DATA	129,	227,	31,	0,	232,	121,	0,	178,	91
1650 DATA	45,	232,	64,	255,	139,	222,	177,	9,	1143
1660 DATA	211,	203,	129,	227,	127,	0,	131,	195,	1223
1670 DATA	88,	232,	188,	0,	232,	34,	288,	139,	1872
1680 DATA	54,	2,	0,	139,	222,	177,	11,	211,	816
1690 DATA	283,	129,	227,	31,	0,	83,	131,	251,	1855
1700 DATA	12,	118,	3,	131,	232,	12,	131,	251,	893
1710 DATA	0,	117,	3,	167,	12,	0,	46,	198,	863
1720 DATA	6,	84,	1,	0,	232,	57,	0,	178,	558
1730 DATA	58,	232,	0,	255,	139,	222,	177,	5,	1886
1740 DATA	211,	203,	129,	227,	63,	0,	232,	39,	1184
1750 DATA	0,	178,	112,	91,	131,	251,	12,	135,	898
1760 DATA	2,	178,	97,	232,	238,	254,	31,	195,	1219
1770 DATA	46,	198,	6,	84,	1,	0,	185,	16,	536
1780 DATA	39,	232,	25,	0,	185,	232,	3,	232,	948
1790 DATA	19,	0,	185,	188,	0,	232,	13,	0,	549
1800 DATA	185,	18,	0,	232,	7,	0,	185,	1,	628
1810 DATA	0,	232,	1,	0,	195,	16,	195,	51,	819
1820 DATA	218,	247,	241,	139,	216,	138,	288,	46,	1447
1830 DATA	8,	6,	84,	1,	46,	128,	62,	84,	479
1840 DATA	1,	0,	117,	2,	178,	248,	128,	194,	868
1850 DATA	48,	232,	168,	254,	195,	0,	0,	0,	889

(Figure 2 ends)

to recall the corresponding directory name when it comes time to display the duplicate filename. To speed up the search, REPEATS also skips the comparison if it is found that the filenames are from the same directory. (DOS won't allow this in any case, so it need not be checked.)

NUMERIC CONVERSIONS There's another routine in REPEATS you may find of particular interest. As I mentioned earlier, all the data that is found in the DIR command is returned from the find first/

next function calls. Conversion of the date and time to decimal is relatively simple and straightforward, though it takes a fair amount of code to decipher it all.

The date (mm/dd/yy) is stored in two bytes, which are mapped as follows:

```
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Y Y Y Y Y Y Y Y Y Y Y Y Y Y Y
```

Similarly the time (hh:mm:ss) is stored in two bytes as:

```
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
h h h h h h h h h h h h h h h
```

To convert the month for decimal display, the word for the date is first rotated 5 bits to the right. The results then look like this:

```
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
d d d d d d Y Y Y Y Y Y Y Y Y
```

The day and year bits are masked off by ANDING the word with 0Fh (binary 00000000 00001111). To convert the results to decimal, we divide by ten and display the quotient as the tens position and the remainder as the ones position.

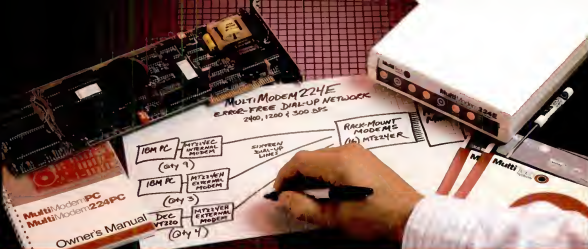
This can easily be done with all the other bits of date and time. Things get interesting, however, when we try to convert the file size to decimal. This number takes up two words. The largest possible number you can represent with 32 bits is 4,294,967,295. Other than disk space, I know of nothing to prevent a file from being that big, but for practical purposes, the largest file size that REPEATS deals with is 999,999,999. (If you have a file bigger than that, I doubt if you have to worry about having a duplicate.)

In order to find out what to display in the 100 millions column you first would divide by 100 million, but that is impossible with the 8088 DIV instruction. The largest a divisor can be is one word or 65535. To overcome this obstacle, the division is broken down into two parts.

First a division is done by 10,000. The remainder is saved and the dividend is divided by 10,000. That gets us the ninth position (10,000 × 10,000 = 100,000,000). The remainder of this division is divided by 1,000 and that remainder by 100 until we get to 1.

This gets us to the fifth decimal position. To get the last four positions, the remainder of the very first division is retrieved and it is divided by 1,000, then 100 until it, too, reaches 1. At that point we have successfully divided by 32 bits with a 16-bit divisor instruction. This may not be the shortest algorithm, but it provides an easy left-to-right display necessary for printer output.

EASING THE EXIT There is one other small trick that REPEATS uses. DOS will check if Ctrl-Break has been pressed when the output is displayed through function call 02h. Indeed, this is the function call REPEATS uses for all of its output. But



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PRODUCTIVITY

■ PROGRAMMING

since the great majority of REPEATS's time is spent in nested loops, loading data, and looking for matches, if the user tried to abort by pressing Ctrl-Break, nothing would happen until the next standard output. An impatient user might pull the three-finger rip cord (Ctrl-Alt-Del).

To avoid such a less-than-graceful exit, function DBh (Check standard input status) is embedded in the loop. This function call returns with AL indicating whether or not the keyboard has been struck. REPEATS isn't interested in any input, so the status is

■ When I ran REPEATS, I expected to find few if any duplicate files. Boy, was I surprised.

ignored, but if DOS detects Ctrl-Break during the call, an interrupt 23h is executed and the user is returned to the DOS prompt. It's these little details that make or break a program. I constantly have them as the number one priority in developing a new program.

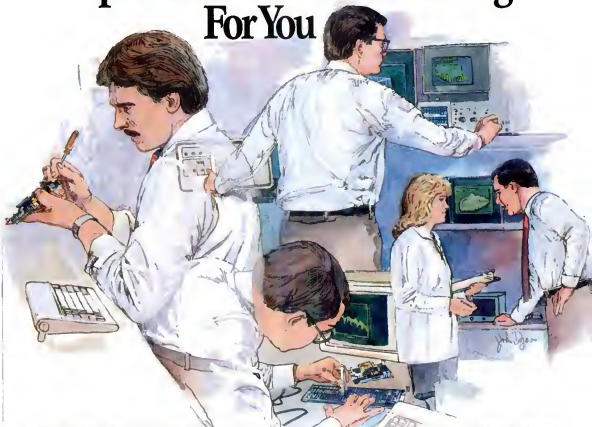
Here's one last thing you should know if you use *Microsoft Windows*. Since REPEATS will usually need 128K of working memory, you should add to the WIN.INI file under the [PIF] section the statement

REPEATS.COM = 128K

You think that you don't need REPEATS? That's what I thought, since I frequently do take the time to tidy up my disk. So when I ran REPEATS on my hard disk I expected to find few if any duplicate files. Boy, was I surprised. [So was I, though clearly most of the 180 drone clones that I discovered on my hard disk were put there by elves while I slept.—Ed.] Try REPEATS on your disk. You may be surprised as well.

Michael J. Mefford is a microcomputer consultant in Glendened Beach, Oregon, and a frequent contributor to PC Magazine.

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■ SPREADSHEET CLINIC

er than two legitimate values in cell C9.

This series of @if functions is the formula equivalent of a column of {x} (or {if}) macro statements, such as

```
/x1C9=1~/xgRETAIL~
/x1C9=2~/xgWHOLESALE~
/x1C9=3~/xgDISCOUNT~
/x1C9=4~/xgLIQUID~
```

In this case, the destinations to which the /xg statement hands off control of the macro would be range names of cells containing instructions for the appropriate calculations. But Mr. Reyburn is right. It's quicker and surer to do it with @ functions!

FINDING THE DAY OF THE WEEK

You sometimes need to know the day of the week of some distant past or future date. While it's hard to find an appropriate calendar for such dates, with 1-2-3 you can easily find the day of the week for any 20th or 21st century date.

Figure 2 is a table you can use for this purpose, and Figure 3 displays the formulas that make the table work. Cells C5 and C7 should contain a date known to be a Sunday. This known Sunday can be tucked away in a corner of the spreadsheet, if its presence in the table is confusing.

The formulas in column D take the number of days between the dates in C5 and C7, subtract by 0 through 6, and divide by 7. Thus, only one of the seven numbers that appear in column D will be a clean division with no decimal place values. The day of the week to the right of that number is for the date entered in C7.

For whatever it's worth, negative numbers in column D mean that the date in C7 is before the known Sunday; positive numbers mean it is later.

Robert Locke
Kenner, Louisiana

There are certainly a lot of ways to gussy up this table if you want to. You can get rid of the numbers in column D, give it the +/- format, and have a string of + signs appear next to the correct day of the week. Or you could even get rid of all those extra days of the week and have only the correct day of the week appear in cell D7 every

	C	D	E	F
3				
4		NUMBER WITH NO DECIMAL		
5	19-Oct-86	PLACES INDICATES DAY		
6	87-Dec-41			
7		-2341	SUNDAY	
8		-2341.1428	MONDAY	
9		-2341.2857	TUESDAY	
10		-2341.4285	WEDNESDAY	
11		-2341.5714	THURSDAY	
12		-2341.7142	FRIDAY	
13		-2341.8571	SATURDAY	
14				
15				

Figure 2: A table that indicates the day of the week for the date entered in cell C7.

	C	D	E	F
3				
4		NUMBER WITH NO DECIMAL		
5	ROATE(86,10,19)	PLACES INDICATES DAY		
6				
7	ROATE(41,12,7)	(C87-C85)/7	SUNDAY	
8		(C87-C85-1)/7	MONDAY	
9		(C87-C85-2)/7	TUESDAY	
10		(C87-C85-3)/7	WEDNESDAY	
11		(C87-C85-4)/7	THURSDAY	
12		(C87-C85-5)/7	FRIDAY	
13		(C87-C85-6)/7	SATURDAY	
14				
15				

Figure 3: The formulas that show how the day-of-the-week table works.

time you put a new date in C7. But why bother? Mr. Locke's table is simple and works fine.

Release 2.0 has an @wday function, but that won't help much because it returns the day of the month, not the day of the week.

CHECKING PRINT RANGE WIDTH

From time to time you have run submissions in Spreadsheet Clinic on how to find the width of a print range. The problem is if you have added columns to your model, it may no longer fit on the page when you print it out. Moreover, it's not easy to count up the width of a spreadsheet if you

have columns of different widths.

The Macro VC in Figure 4 makes this job easy. To use it, put the cursor in the left-hand column of the print range, just below the active part of the worksheet. In this case it's C17. When you run it with Alt-C, the macro first enters an @cell function to establish the width of the first column. Then it begins a copy command that will copy the @cell formula to every column in the print range. The macro pauses to let you move the cursor to the right, highlighting the print range. After you complete the copy operation with <Enter>, the macro creates a second row

	C	D	E	F	G
3	VC	#cell("width", {up})			
4		/c, {?}			
5		/c {down}			
6		{down}{right}+{left}+{up}			
7		/c, {up}{end}{right}{down}			
8		{end}{right}			
9					
10					
11	VA	#cell("width", {up})			
12		/c, {?}			
13		{end}{right}{right}			
14		#sum({left}, {end}{left})			
15					
16		6	4	3	12 ==> Individual column widths
17		6	18	13	25 ==> Cumulative column widths
18					

Figure 4: Two macros that count the width of a print range.

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■ SPREADSHEET CLINIC

of numbers that displays cumulative column widths. Examples of the output are in rows 17 and 18 of Figure 4.

If you change any column widths after you run this macro, you have to update the width figures by hitting {calc} (F9), even though the CALC indicator will not be on.

Ronald Baker
Delphi, Indiana

This is a clean macro that does a dirty job. The {up} in the first line makes the formula reference a cell other than the one containing the formula, thus avoiding a CIRC error. In case you don't need a running total of cumulative column widths, I've written a different version of the macro, \A, that simply sums the individual column widths.

ROOM TO BOOT

One of my biggest complaints about Release 2.0 of 1-2-3 is that there isn't enough room on the system disk for DOS. But,

I've discovered an easy fix. You can correct this problem with the program-copying utility, *CopyII PC*. A considerable

■ There are still plenty of people who don't have hard disks, and Lotus really snubbed them when it didn't leave room on the system disk for DOS.

amount of space on the system disk is taken up by hidden files used in the copy protection scheme, and *CopyII PC* deletes them. Now you can include not only your

boot-up files but even a few small memory-resident utilities.

Ted Larson
Fairport, New York

Yes, there are still plenty of people who don't have hard disks, and I think Lotus really snubbed them when it didn't leave enough room on the system disk for DOS. If it takes CopyII PC to scratch out enough space, I think you're entitled to use it.

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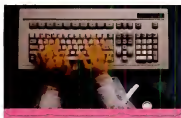
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■ FRANK J. DERFLER, JR.

CONNECTIVITY CLINIC



A help-wanted ad for a network administrator, getting a dot matrix printer to go the distance, the total picture for network security, and identifying active COM ports.

TRAINING A LAN MANAGER

Our "prototype" network (Corvus Omninet with two workstations) has been running for 6 months. The main things we learned from this prototype are that LANs are complex and that somebody has to be in charge. Now various departments are sneaking in their own LAN solutions like they used to sneak in PCs. We have to do something. How do we train a network administrator and who should it be? How big a job is it?

Installing a prototype network is often a way for information system managers to delay making a decision. The life span of a "prototype" LAN is about as long as the typical user is willing to be called a novice: until the first system boot. You need to designate a LAN system administrator right now. Qualifications? I think that the three most important characteristics of a LAN manager are like the three most important things in buying real estate. Instead of location, location, and location, they are DOS, DOS, and DOS.

The network administrator has to know more DOS tricks than even the usual PC training or Information Center support staff member. The most important thing to know is how to write powerful batch files. Find someone who reads the Programming/Utilities column in this magazine and you will have a good start.

The network administrator should also be comfortable with DBMS applications, because they are the most fruitful and complicated applications to implement on a LAN. The most successful network admin-

istrators we know were members of the work group who learned about LANs, rather than members of the DP staff who tried to serve the work group.

When the job of network administrator becomes a full-time position depends on the amount of support available from corporate training, maintenance, programming, and purchasing staffs. If the network administrator is responsible for all of those tasks related to the network, you'll need a full-time person when your network grows beyond half a dozen users (persons using the network as opposed to just network stations). However, that person can then handle a 50- to 100-user network if the jobs performed on the workstations are relatively homogeneous. If a network administrator has help from professional training, purchasing, and other support groups, the job can be a part-time position or one that is shared between two persons even if the LAN grows to several dozen active users.

■ The life span of a "prototype" LAN is about as long as the typical user is willing to be called a novice: until the first system boot.

DISTANT PRINTERS

We have been told we need to install a coaxial-cable LAN with a print server, but I'm not convinced. Our accounting department wants to send batch invoices to a printer in the warehouse. The cable run is about 250 feet. We have the dot matrix printer we want to use and all the forms are set up for it in the software, but everybody tells us the distance is too far to run a parallel printer cable. Is this true and what alternatives do we have?

In order of importance, the distance you can run a parallel printer cable depends on how finicky the printer is, the quality of the cable, and the amount of electrical interference the cable picks up. The typical maximum distance is 15 feet and the absolute maximum is about 25 feet. But if you don't need a LAN print server for any other reason, you don't have to establish one just to extend a parallel printer.

An effective and economical solution is to use a parallel-to-serial converter at the PC end, run 250 feet of twisted-pair telephone wire to the printer location, and attach the printer to the wire with a serial-to-parallel converter. The two converters will cost a total of \$160 at retail prices. I like the devices made by Integrated Marketing Corp. in Sunnyvale, California. Its converters run at 38.4 kilobits per second on the serial side, so you won't notice any difference in printing speed. The whole connection is invisible to the people in accounting, to the people in the warehouse, and to the software. Call IMC at (408) 730-1112 or (800) 621-0854, ext. 309.

■ CONNECTIVITY CLINIC

AT KEY LOCK

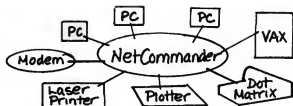
We are running Novell's *Advanced NetWare/286* on the three servers in our network. We recently upgraded to the latest IBM PC ATs with the new keyboards.

And now, once the dedicated server comes up, the NumLock cannot be turned off. The Ctrl-Alt-Del combination doesn't work to reboot the system. When we boot the machine with PC-DOS, everything

works fine. Do you have any ideas or suggestions about this situation?

You have to unlock NumLock during the boot cycle. Hit the key a few times while the system is booting until the light goes out. The three-finger reset doesn't work because Advanced NetWare/286 is running the 80286 processor in the protected mode. If you need to reset the machine, you have to go for the Big Red Switch.

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Fortunately, there are effective things you can do to protect your networked data.

■ Fortunately, there are effective things you can do to protect your networked data.

Since you haven't bought PCs yet, look seriously at the diskless workstations (dubbed LANstations) available from Novell, 3Com, Pure Data, Kimtron, NCR, and other companies. These machines don't include a disk drive, so your files can't be put on a floppy disk and taken out the door. You can choose LANstations from several price ranges and capabilities. If your office is like most telemarketing firms, small-size systems like 3Com's 3Station will be welcome.

Often, network programs can be set up so that access to a printer is controlled through a password. This prevents unauthorized persons from making printed copies of your lists. Password protection of subdirectories (available on Fax Research's 10-NET) allows segregation of



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Christopher O'Malley

PERSONAL COMPUTING, April '86



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Winn L. Rosch

PC MAGAZINE, May 27, 1986

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Jerry Pousmelle, BYTE, Feb. '86

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data so that an individual works only with appropriate portions of the total database.

Another simple thing you can do to protect the integrity of files is to set the read/write attribute to read only. The DOS command `ATTRIB +R filename.ext` sets the file attribute to read only and prevents anyone from erasing or changing the file.

You should also take some physical precautions. Protect the server from physical access or abuse by placing it in a controlled area and removing the keyboard after the network is running. Keep passwords confidential and change them when an employee leaves. By the careful selection of equipment and the use of reasonable security measures, you can protect your corporate information assets.

ZERO-SLOT FRUSTRATION

Connecting RS-232C LANs can be a frustrating job because the RS-232C standard isn't very standard. Is there an efficient way to see what communications ports are active in a PC?

Before you load any RS-232C networking product, use the DOS DEBUG program to display the serial ports DOS recognizes as active in a particular machine. Call DEBUG and at the - prompt enter D 40:0. The display will show the hex address (bit reversed) for COM1 and COM2. A listing of F8 03 (for COM1) and F8 02 (for COM2) shows that the ports are active. If the numbers 03 or 02 are 00 instead, then DOS doesn't recognize the port. Another solution is to use one of the public domain "survey" programs that describes a machine's hardware environment. A good one is PC Magazine's STATUS.COM (PC Lab Notes, Volume 6 Number 8).

NETWORK YOUR QUESTIONS

Connectivity Clinic gives you practical solutions to networking problems of all types. We'll pay \$50 for any tips we print, plus an extra \$25 if you submit your letter on a disk—and we'll gladly answer any questions you have, at no charge. Mail your contributions to Connectivity Clinic, PC MAGAZINE, One Park Avenue, New York NY 10016, or contact Frank J. Derfler, Jr., via MCI Mail (use Derfler's special box named CONNECTIVITY CLINIC).

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■ NEIL J. RUBENKING

TURBO POWER USER



Finding the environment string; keeping overlay files from crashing; an easy way for programs to reference themselves; re-enabling Ctrl-C in programs with I/O redirection.

REACHING THE ENVIRONMENT

Recent columns in *PC Magazine* have discussed the environment and the information it contains, and have included DOS batch files and a BASIC routine. After reading this material, I decided to attempt to reach the environment string from a Turbo Pascal routine that may be useful to other Turbo power users.

The Environment function of Figure 1 accepts as its input a string which is the left side of an assignment made by the DOS Set function. The function returns the value assigned to this parameter, namely, the right side of the assignment. You could use this function to test for special hardware by setting such a parameter in a batch file. For example, when loading a mouse driver, if the installation batch file included the DOS command

```
SET MOUSE = YES
```

the following TURBO expression would return the status of the mouse driver:

```
IF (ENVIRONMENT('MOUSE') = 'YES') THEN
  (The mouse driver is loaded.)
ELSE (No mouse driver loaded.)
```

The environment parameters comprise a list of ASCII strings (strings of characters terminated by an ASCII 0). An empty string (a single ASCII 0) marks the end of the environment. The word at offset 002C hex from the start of the Program Segment Prefix (PSP) holds the segment of the environment information. The Environment function uses an absolute integer value to pick up this segment address. It scans the environment, keeping track of both the left

```
(Pascal)
PROGRAM GetEnvironment;

(This program prints the current PATH; and Command Specification CONSPC
to demonstrate the Environment function.)

TYPE
  AnyString = STRING[255]; (Define a type for any length string.)

VAR
  CurrentPath : AnyString; (A variable to hold the current PATH information.)
  .....
FUNCTION Environment(ParamString : AnyString) : AnyString;
VAR
  EnvironmentSegment : Integer; ABSOLUTE CSeg : $$$2C;
  (The location in memory where environment string begins.)
  MemOffset : Integer; (Index used as the offset from the starting
  environment string location.)
  Loc :
  (Index into the input string. Used for the
  loop to convert it to uppercase.)
  MemValue : Byte; (Current ASCII value of byte within the
  environment string.)
  LeftSide :
  (The left side of the assignment statement.)
  RightSide : AnyString; (The right side of the assignment string.)
  (Flag telling if the end of the environment list
  was found, i.e. a double ASCII 0 found.)
  EqualSignFound : Boolean; (True if the equal sign has been found for the
  current assignment statement.)

BEGIN
  (Initialize the local variables.)
  NoMoreParams := False;
  MemOffset := 0;

  (Convert the input string to all uppercase for a possible match to the
  left side of an environment assignment.)
  FOR Loc := 1 TO Length(ParamString) DO
    ParamString[Loc] := UpCase(ParamString[Loc]);

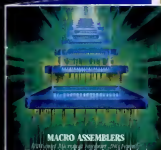
  (Search the set of environment ASCII strings for a match on the input
  string. Exit the loop if a match is found or the end of the environment
  space has been detected.)
  REPEAT

    (Initialize the variables pertaining to the current assignment statement.
    Lengths of each side of the assignment should be zero, no equal sign has
    found.)
    LeftSide[0] := 0;
    RightSide[0] := 0;
    EqualSignFound := False;

    (Get the first character of the next assignment string. If the first
    character is an ASCII 0, then the end of the environment information
    has been reached.)
    MemValue := Mem[EnvironmentSegment + MemOffset];
    MemOffset := MemOffset + 1;
    NoMoreParams := (MemValue = 0);

  (continues)
```

Figure 1: A routine to search the environment.



Focus on the technical issues that concern *you* in PC TECH JOURNAL

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■ TURBO POWER USER

```

[Scan the environment for a complete assignment statement. Save each side
of the assignment in separate strings.]
WHILE (MemValue <> 0) DO
  BEGIN
    IF (Chr(MemValue) = '=') THEN
      EqualSignFound := True
    ELSE
      IF EqualSignFound THEN
        RightSide := RightSide + Chr(MemValue)
      ELSE
        LeftSide := LeftSide + Chr(MemValue);

    [Get the next character from the environment string.]
    MemValue := Mem[EnvironmentSegment:MemOffset];
    MemOffset := MemOffset + 1;
  END [WHILE];

  UNTIL ((LeftSide = ParamString) OR NoMoreParams);
  Environment := RightSide; [Return the right side of the selected assignment
statement. If no match was found the result will
be a null string.]

END [Environment];
[*****]

BEGIN [Main Program]

  [Display the current location for the command file COMMAND.COM]
  WriteLn('The current COMSPEC is ', environment('comspec'), '');

  [Get the current PATH. Then print a message showing the PATH.]
  CurrentPath := Environment('PATH');
  WriteLn('The current PATH is ', CurrentPath, '');

END. [Main Program]

```

(Figure 1 ends)

and right sides of each assignment. If the left side matches the input parameter, it returns the right side as the function result. If it doesn't find a match, it returns an empty string. DOS always stores the left side of an environment assignment in uppercase, so the function converts the input parameter to uppercase before seeking a match. The right can be upper- or lowercase.

Brian R. Spinzig
Barnhart, Missouri

Turbo programmers who use overlays take note: this technique can save you from an ugly crash. Suppose the user puts your overlaid program in a directory that's on the path and calls it from another directory. When the program tries to access its overlay file, it will look in the current directory. Not finding the file, it will crash with RunTime Error SF0 "Overlay File Not Found."

To prevent this, your program can search the path itself at startup and use the OverPath routine to set the path where it finds it. First use the Environment function to get the path. Break down the path string into its separate directories, and check whether your overlay file exists on one of them. If so, set OverPath to that directory. If not, halt the program gracefully with a descriptive message.

There are two other pitfalls for overlaid programs. First, your users can rename

the program. If they also rename the overlay, it will work when the program runs from the current directory, but the path-searching method above assumes that the overlay filename is hard-coded into your program. Second, under DOS 3.x, you can invoke a program in any subdirectory simply by spelling out the full path, e.g.,

B>C:\FAROUT\OFFBEAT\STRANGE\UTIL

In such a case, searching the path won't help, because the program is not on the path. The next tip solves this problem.

FINDING YOURSELF

According to the DOS Technical Reference manual, DOS places the name of the currently operating program or process loaded by the EXEC function call (4Bh) just beyond the environment, the segment of which is located at offset 2Ch in the program segment prefix. The manual further notes that the filename will include the drive and path where the file is located. In other words, if you entered

ws myprog /x/d

and the program WS was found on the path in the directory "c:\editors\text", the string in the environment would contain the full name including the path, i.e.,

=C:\EDITORS\TEXT\WS.COM"

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■ TURBO POWER USER

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```
(* (C) Copyright 1986, D. M. Armstrong-Alien *)
[PS]
PROGRAM Self;
TTFS
e64 = STRING[64]; (* length of a filename w/path *)
FUNCTION Self : e64; (* Require MS/PC-DOS v3.00 or later *)
VAR
  invaseq : Integer ABSOLUTE CSeg : $$$C;
  i : Integer;
  temp : e64;
BEGIN
  i := 0;
  temp := '';
  (* Read thru the environment until we get to the end, *)
  (* i.e. two null bytes. *)
  WHILE Mem[invaseq+i] <> 0 DO
    i := i+1;
    i := i+4; (* Skip the two null bytes end word count *)
    (* Get the dir\path\filename.ext as passed to the EXEC function. *)
    WHILE Mem[invaseq+i] <> 0 DO
      BEGIN
        temp := temp+Chr(Mem[invaseq+i]);
        i := i+1;
      END;
    Self := temp;
  END;
  WriteLn('This program is named ', Self, '.');
END.
```

Figure 2: A program that can locate itself on disk.

```
[PS]
PROGRAM DOSVersion;
VAR
  X,Y : Integer;
PROCEDURE Dos_Version(VAR Maj, Min : Integer);
TYPE
  Registers = RECORD
    CASE Integer OF
      1 : (AX,BX,CX,DX,SP,SI,DI,DS,ES,Flags : Integer);
      2 : (AL,AH,BL,BH,CL,CH,DL,DH : Byte);
    END;
VAR
  R : Registers;
BEGIN
  WITH R DO
    REGISTERS
    AH := $30;
    MOVDS[R];
    IF AL = 0 THEN REGISTERS Maj := 1; Min := 0; END
    ELSE BEGIN Maj := AL; Min := AH; END;
  END;
END;
BEGIN
  Dos_Version(X,Y);
  WriteLn('DOS version ',X,'.',Y);
END.
```

Figure 3: A simple routine to check the current DOS version.

This makes it easy for a program to find its own name and determine where it is located. This is very useful for loading overlays or configuration files. The program SELF, shown in Figure 2, demonstrates the technique, using the ABSOLUTE declaration to get the information from the PSP.

D.M. Armstrong-Alien
Shelbyville, Tennessee

This technique will work only under DOS 3.x, but it's less necessary in previous versions of DOS. That's because before DOS 3.x you could only run a program either

from the current directory or from a directory on your path. As seen in the previous program (Figure 1), you can locate the path string in the DOS environment and search it yourself. Under DOS 3.x you can run any program simply by spelling out its full pathname. By combining these two methods with the simple test for the current DOS version used in the DOS_Version procedure that I've included in Figure 3, you could construct a nearly foolproof procedure for locating your program's data files or overlay files, no matter where the program was called from.

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■ TURBO POWER USER

REVIVING CTRL-C

Version 3.0 of Turbo Pascal has two compiler directives (SP and SG) that force I/O to go through the DOS standard input and output routines. The DOS standard routines can be redirected (using the < and > symbols), which is very useful for writing UNIX-like filter programs. Unfortunately, however, when a program uses the SP directive, the normal Ctrl-C checking performed by Turbo Pascal does not work.

The short program included here (Figure 4) shows how to remedy this problem. The program works as follows. When COMMAND.COM loads a .COM program, it reserves 256 bytes of memory just before it for the Program Segment Prefix. Included in the PSP at locations CS:000E through CS:0011 is the address of the DOS Ctrl-C handler, which is normally stored in the vector for interrupt 23h (INT \$23). Some programs, including those compiled with Turbo Pascal, replace the INT \$23

```
{SP+,PS12,GS12}
{Compiler options indicate Range checking on, Redirection enabled}
TYPE
  reg_record = RECORD CASE Integer OF
    1 : (AX, BX, CX, DX, SP, SI, DI, DS, ES, Flags : Integer);
    2 : (AL, AH, BL, BH, CL, CH, DH, DE : Byte);
  END;

PROCEDURE Set_interrupt(InterruptCode, Segment, Offset : Integer);
  {Install Segment:Offset address in interrupt vector InterruptCode.}
  VAR reg : reg_record;
  BEGIN
    WITH reg DO BEGIN
      AX := $23;           { MS-DOS Function to Set Interrupt Vector }
      AL := InterruptCode;
      DE := Segment;
      DS := Offset;
      Move(reg);           { INT 21h }
    END;
  END;

PROCEDURE Break_Handler;
  BEGIN Halt; END;

PROCEDURE Enable_control_C;
  CONST CTRL_C_CODE = $23;
  VAR segment, offset : Integer;
  BEGIN
    (*Set_interrupt(CTRL_C_CODE, Mem(CSeg:$0010), Mem(CSeg:$000E));*)
    Set_interrupt(CTRL_C_CODE, CSeg, DSeg(Break_Handler));
  END;

VAR line : STRING[255];
```

(continues)

Figure 4: CTRL_C.PAS a way to enable Ctrl-C safely in a program that uses I/O redirection.

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```

BEGIN
  Enable_control_C;           { Place this call at the top of your program }
  { The following code is a filter that just copies its input to the output }
  WHILE NOT EOF DO BEGIN
    ReadLn(line);
    WriteLn(line);
  END;
END;

```

(Figure 4 ends)

vector with the address of an internal Ctrl-C handler. On termination of such a program, DOS restores the vector from the stored value in the PSP. However, as noted, the Turbo Ctrl-C handler does not recognize Ctrl-C when I/O is redirected. The program in Figure 4 simply replaces INT \$23 with the address of a procedure that HALTs any Turbo program.

Any program that uses the \$P directive and needs to be able to abort with Ctrl-C can benefit from this technique. Simply place the call to Enable_control_C at the beginning of the program. Programmers may want to experiment with various settings of the \$C and \$U compiler directives as well as the DOS BREAK flag. Various

combinations swap between speed and the capability to abort with Ctrl-C.

To demonstrate the program, first compile it to a .COM file and then run it by typing CTRL-C <CTRL-C.PAS. The less-than symbol redirects the standard input to come from the file CTRL-C.PAS. Thus, the program will read its own source code and print it to the screen. You can interrupt it at any time by pressing Ctrl-C.

C. Michael Bell
Walla Walla, Washington

As originally written, Mr. Bell's program simply restored the DOS INT \$23 vector from the value saved in the PSP. While I appreciate a simple solution, unfortunate-

ly Turbo Pascal takes over several interrupts, not just \$23. The normal Turbo program termination routines, which I've modified Mr. Bell's program to use, restore all the affected interrupts. My thanks to Kim Kokkonen of Scotts Valley, California, for pointing out the danger.

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■ PAUL SOMERSON

USER-TO-USER

Techniques to reconfigure the new IBM keyboard the way it should be, and restore IBM's CMOS configurations after a battery change.



KEYBOARD RELIEF

IBM's newest keyboard puts the CapsLock next to the A key instead of the Ctrl key, so *WordStar* users end up totally fingerlocked. To make *WordStar* users once again ambidextrous, I wrote a program that switches the Ctrl and CapsLock keys. Instead of teaching your left little finger where the new Ctrl key is, you can use IBMFIX.COM to relocate the two keys closer to their old familiar positions.

To create IBMFIX, assemble, LINK,

and EXE2BIN the .ASM listing in Figure 1, or run the BASIC IBMFIX.BAS program in Figure 2. IBMFIX.COM is a resident program that should be placed in your AUTOEXEC.BAT. Also, be sure to load IBMFIX before *SideKick*. You'll have to reboot if you wish to return the meanings of the keys to the new IBM assignments.

IBMFIX intercepts INT 9H, the keyboard hardware interrupt. Every time you press a key, IBMFIX examines the keystroke to see if it is either the Ctrl or Caps-

Lock key. If it's not, IBMFIX passes control on to the original INT 9H to interpret the keystroke normally. Otherwise, IBMFIX changes the keyboard flag byte at 40:17h to reflect the toggle of the CapsLock key or the depressing or release of the Ctrl key.

Michael Mefford
Glenden Beach, Oregon

IBMFIX really pulled a fast one with its new keyboard, so much so that we've heard ex-

```

IBMFIX.ASM
; swaps Ctrl and Capslock keys.
; Resident program to be loaded once.
; Load before SIDKICK.
; Reboot to reset to normal.

CODE SEGMENT
ASSUME CS:CODE,DS:CODE
ORG 1000

START: JMP INITIALIZE

;
; DATA AREA
;
COPYRIGHT DB 'Copyright 1987 Biff-Owie Publishing Co., Inc.'
PROGRAMMER DB 'Michael J. Mefford'
CPL_FLAGS DB 0
CAPS_FLAG DB 0

;***** KEYBOARD INTERRUPT *****;

KBD_INTERRUPT:
;Save registers.
PUSH AX
PUSH DS
;
MOV AX,400 ;Point to BIOS data area
MOV DS:[170] ;and retrieve keyboard flag.
MOV AX,400 ;Retrieve scan code of keystroke.
;
CNTRL_PRESSED:
;Is it the real Ctrl key pressed?
JNZ CNTRL_RELEASE
;If yes, is it a typematic repeat?
;If yes, ignore.
;Else, toggle Caps flag bit.
;Indicate that it is depressed.
;Store and exit.
;
CNTRL_RELEASE:
;Is it the real Ctrl key released?
;If no, check real Caps.
;Else, flip an scan press is valid.
;Exit.
;
CAPS_PRESSED:
;Is it the real Caps key?
;If yes, check Caps release.
;Else, turn on Ctrl flag bit.
;Store and exit.
;
CAPS_RELEASE:
;Is it the real Caps key released?
;If no, pass on control to INT 9H.
;
;*****
;
; This routine swaps the keyboard and issues an 80i to the 8254.
;
;*****
;
; This is the exit to the original INT 9H interrupt.
;
NO_BUSINESS:
;Restore registers.
POP AX
POP DS
;
; This is the install routine.
;
;*****
;
INITIALIZE:
MOV AX,3500h ;Get keyboard interrupt.
INT 13h
;
;Save old interrupt.
MOV WORD PTR OLD_KEYBOARD,DI
MOV WORD PTR OLD_KEYBOARD+2,DI
;
;Install new interrupt.
MOV DI,OFFSET NEW_KEYBOARD
;
;
MOV AX,3500h
INT 13h
;
;Permanently but stay resident.
MOV DI,OFFSET INITIALIZE+1
INT 27h

CODE ENDS
END START

```

Figure 1: IBMFIX ASM assembly language source code to swap CapsLock and Ctrl keys. Load the IBMFIX.COM file before SideKick.

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PRODUCTIVITY

■ USER-TO-USER

```

000 * Program for creating IMPFIX.COM
110 CLS:PRINT "Checking DATA; please wait..."
120 FOR B=1 TO 9:FOR C=1 TO 17:READ A$:IF C17 THEN 140
130 I4=I4+VAL(A$)
140 NEXT:TEXT
150 IF I4=12937 THEN RESTORE:GOTO 180
160 PRINT "ERROR: CHECK THE LAST NUMBER IN"
170 PRINT "EACH DATA STATEMENT--THEN REDO":END
180 FOR B=1 TO 9:FOR C=1 TO 16:READ A$:TTL=TTL+VAL("6H"+A$)
190 NEXT
200 READ S:IF S=TTL THEN 220
210 PRINT "DATA ERROR IN LINE":B*10+260: -- REDO:END
220 TTL=S:NEXT:RESTORE
230 OPEN "IMPFIX.COM" AS #1 LEN=1:FIELD #1,1 AS D$
240 FOR B=1 TO 9:FOR C=1 TO 16:READ A$
250 LSET D$=CHR$(VAL("6H"+A$)):PUT #1:NEXT:READ DUMMYS:NEXT
260 CLOSE:PRINT "IMPFIX.COM CREATED"
270 DATA EB,78,98,08,08,08,08,08,9C,58,1E,B8,48,08,8E,DB,1363
280 DATA 8A,26,17,08,EA,68,3C,1D,75,1B,2E,88,3E,07,81,1,1081
290 DATA 74,33,8A,C,24,48,34,48,88,EA,4F,8A,E8,2E,C6,06,1748
300 DATA 07,81,81,EB,1C,3C,9D,75,88,2E,C6,86,07,81,08,EB,1187
310 DATA 14,3C,3A,75,88,08,CC,04,EB,07,3C,3A,75,1C,88,EA,1585
320 DATA FB,88,26,17,08,EA,61,8A,EB,0C,8C,86,61,86,EB,2198
330 DATA 61,FA,88,28,6E,28,1F,58,9D,CF,1F,58,9D,2E,FF,2E,1293
340 DATA 03,81,88,89,35,CD,21,89,1E,03,81,8C,06,85,81,BA,9977
350 DATA 88,81,88,89,25,CD,21,8A,73,81,CD,27,08,08,08,08,1023

```

Figure 2: *IBMFIX.BAS* program to create *IBMFIX.COM* CapsLock/Ctrl key switcher. Load the *IBMFIX.COM* file it produces before loading *SideKick*.

executives at several leading companies refer to it as the "IBM Ronco keyboard." The only thing it slices, dices, and minces is the typing speed of users long accustomed to the standard IBM configuration. This program puts things back the way millions of users want them.

PCAT LIFESAVER

The configuration information for the IBM PC AT is kept in a 64-byte CMOS memory chip that's maintained by battery even when the machine is turned off. A failing battery can cause errors at boot-up and trigger bad configuration records or failed battery messages. Typical batteries have a useful life of about 3 years, so many of the original crop of ATs are due for a battery change. However, when you remove the battery, you lose all the configuration information and have to run the SETUP program to restore the configuration.

To make this chore easier, I created two short programs, CMOSGET and CMOSPUT. CMOSGET reads the contents of the CMOS memory chip and writes it to standard output; redirecting this output to a file saves the 64 bytes of information. CMOSPUT performs the complementary func-

tion. It reads from standard input and loads the CMOS chip with the saved data. It again uses redirection to read the data file created by CMOSGET.

You can create these programs from the assembly language listings in Figures 3 and 4 using Version 2.0 or later of the Macroassembler. Or you can run the BASIC CMOS.BAS program in Figure 5.

You can't simply restore all the old data, however, since you'd end up resetting the time and date that were active

- CMOSGET writes the contents of the CMOS chip to a file and saves the 64 bytes of data.

when you saved the 64 bytes, and would have to use SETUP to update them. CMOSPUT avoids this problem by getting the current time and date from DOS and then using the BIOS to update the battery-

■ USER-TO-USER

[illegible]

Figure 3. Assembly language listing for CMOSGET.COM.

```

J CRNDPT = 0; We are outside of the CMOS memory area. Date is read from BIOS and we are not involved in the file transfer.
J LVC, -CMOSR -CMOSDQ; No. The DATE and TIME are set to the values currently active in CMOS. Set them before starting the date.
J TO Create: RAMB OBJECT;
J LVC, -CMOSR -CMOSDQ;
J EXEMPIE -CMOSPUT -CMOSPUT.COM

CMOS REQUEST PARAM PUBLIC "CODE"; ;start CODE segment
ASSEMB CR0,CR1,CR2,CR3,RG,SG,CGU,SG,CGU; ;CODE files format
CMOS CR0,CR1,CR2,CR3,RG,SG,CGU,SG,CGU; ;CODE files format

CMOS_ADR EQU 786 ;Address part of CMOS
CMOS_DATA EQU 718 ;Data part of CMOS
RDW_BYTES EQU 4 ;Number of bytes in CMOS

NAME CMOS NAME ;

GET_NEXT_BYTE:
MOV AX,BX_METER ;Number of CMOS bytes
MOV AX,7 ;
INT 31H ;Keyboard interrupt w/o echo
MOV BX,AX ;The DOB
MOV BX,AX ;Write byte in AM

MOV AL,BX_METER; ;Calculate
SUB AL,CX ;Byte to rewrite
CLD ;no interupte
JMP CMOS_ADR_AL ;write byte in coming
JMP $ENDP $+2 ;delay for slow I/O portte
MOV AL,BX ;read byte
OUT CMOS_DATA ;write byte
PUL EDI ;allow interupte
LOOP GET_NEXT_BYTE ;Repeat until done
=====
; update the time and date. DOS gives values in hex. CMOS stores date
; as BCD. We must convert it to binary.
;
; 1st 2CH
; 2nd 2CH
; 3rd 2CH
CALL HEXDEC

```

Figure 4: Assembly language listing for CMOSPUT.COM.

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TABLE OF BENCHMARK RESULTS

This table shows the results of the processor/coprocessor speed tests using the April 1986 release of PC Magazine's 'PC Labs Benchmark Tests'. These are public domain programs, and are available on diskette

from PC Magazine, or via the PC Magazine bulletin board. These results were obtained by us at PCSG, and are not yet official published PC Magazine figures.

The last line in the table, the

Norton System Information Test, is not from PC Magazine, but is part of the popular 'Norton Utilities.' The version we used was 3.1, which is the latest version but may not give identical results to older versions.

	IBM PC	IBM AT	BREAKTHRU 286	
Clock speed in MHz (IBM PC is 4.77)	4.77	6	8	12
Empty Loop	1	1.99	3.34	5.15
Integer add from memory	1	3.35	4.41	6.02
Integer multiply from memory	1	6.06	6.55	8.3
Floating point without coprocessor	1	3.33	4.42	5.76
Prime number test	1	1.95	2.85	3.7
Lotus 123 macro (640K)	1	2.64	3.69	4.62
Lotus 123 macro (256K)	1	1.77	3.54	4.38
Norton System Information Test	1	5.73	7.34	10.2

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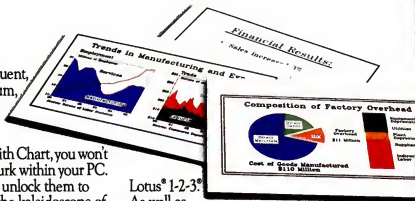
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■ CHARLES PETZOLD

PC TUTOR



Accessing 64 palette colors with an EGA and Enhanced Color Display; discovering how 8-, 16-, and 32-bit chips address memory; and aiding color and monochrome board coexistence.

64 COLORS IN BASIC

I've recently been using QuickBASIC 2.0 with my PC, which has an Enhanced Graphics Adapter (EGA) board. According to the QuickBASIC documentation, I should be able to select 16 colors from a total of 64 when using SCREEN 9. I have found no reference to how it is possible to access any of the other 48 colors. How can I do this?

Nathan Janco
Tulsa, Oklahoma

What you want is the **PALETTE** statement. The **PALETTE** statement allows you to map any of the normal 16 attribute codes into any of the 64 colors that are available on the EGA when attached to an Enhanced Color Display (or compatible) and running in a video mode that uses 350 scan lines. (The 64 colors are not available on the older Color Display, or when using video modes that use 200 scan lines.)

The **PALTEST.BAS** program shown in Figure 1 runs under both BASIC 3.2 and QuickBASIC 2.0. It draws a large block using attribute code 1 (normally blue), maps that into palette color 0 (black), and waits for you to press a key. Pressing any key increments the palette color, so you can step through the 64 possible palette colors. Ctrl-Break exits. If you run this program under BASIC 3.2, you'll want to execute **CLS** and **PALETTE** statements after you exit the program to return things to normal.

If many of the colors seem to look indistinguishable when you run **PALTEST**, you may want to adjust the brightness and con-

```
100 DEFINT A-Z
110 CLS
115 COLOR 1
120 FOR ROW = 5 TO 20
130 LOCATE ROW,5
140 PRINT STRING$(70,219)
150 NEXT ROW
155 COLOR 7
160 WHILE (1)
170 FOR PALCOLOR = 0 TO 63
180 PALETTE 1,PALCOLOR
190 LOCATE 2,16
200 PRINT "Color value";PALCOLOR;"or octal ";OCT$(PALCOLOR);" "
205 WHILE (LEN(INKEY$) = 0) : WEND
210 NEXT PALCOLOR
220 WEND
```

Figure 1: **PALTEST.BAS**, a fast and simple 16-line program, allows you to page through the 64 possible EGA colors when using an EGA board and an Enhanced Color Display. This little routine runs under BASIC 3.2 or QuickBASIC 2.0.

trast of your monitor. The colors look most distinct at a brightness level higher than what you'll probably find comfortable for normal work.

You'll notice that this program does not change the video mode and just uses the default **SCREEN 0**. The tables on pages 385 and 448-449 of the QuickBASIC 2.0 manual are somewhat inaccurate. If your EGA is attached to an Enhanced Color Display, you can use the 64 colors with either **SCREEN 0** or **SCREEN 9**. In the other color modes (**SCREEN 1**, **SCREEN 2**, **SCREEN 7**, and **SCREEN 8**), you can map any of the available attributes to any of 16 palette colors. For instance, in **SCREEN 2** (normally 640 by 200 black and white) you can set the background and foreground colors to any of 16 colors.

It's usually not possible to display more than 16 colors at once. This is rather frustrating if you're trying to compare the col-

ors. However, you may want to try out the **EGAPALET.COM** program from my Programming/Utilities column on the EGA ("Exploring the EGA, Part 1," PC Magazine, Volume 5 Number 14). It's a small program that uses some insane assembly language code to actually show all 64 colors on the display at once. The technique would not be suitable for normal programs.

MICROPROCESSOR ADDRESSING

I have a question about the maximum amount of memory a computer can access. I know that computers based on the Intel 8080 and Zilog Z-80 chips can access 64K bytes. The fact that these are 8-bit microprocessors but can access 65,536 (2 to the 16th power) bytes leads me to believe that a microprocessor can use double the number of data bits for addressing.

Based on this, it seems to me that a 16-

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PRODUCTIVITY

■ PC TUTOR

bit microprocessor like the Intel 8088 or 80286 can use 32 bits of memory for addressing 4 gigabytes, and a 32-bit chip like the Motorola 68000 or Intel 80386 can use 64 bits for addressing 2^{64} bytes of memory. But this is not so. Why do I never see numbers this high?

Henry H. Hartley
Juneau, Alaska

Every microprocessor has a particular register size used for storing data within the chip. This register size is 8 bits (a byte) for the 8080 and Z-80; 16 bits (commonly called a word) for the 8088, 8086, and 80286; and 32 bits (commonly called a long word or double word) for the 80386. Often the chips can divide these larger registers into several smaller registers as well.

The microprocessor must include an "arithmetic logic unit" to perform arithmetic and logical operations on this data. It must be able to do such things as addition and subtraction, logical ANDs and ORs, bit shifts, and negation. For speed, the arithmetic logic unit must be able to operate on the whole register at once.

The microprocessor must also generate an address for accessing data from memory. Often the microprocessor must perform arithmetic operations on the address. For instance, when accessing machine code instructions from memory for execution, the microprocessor must be able to increment the address to the next instruction. When the microprocessor calculates an effective address for accessing data from memory, it must often add several registers together.

It is most convenient if the microprocessor uses the same arithmetic logic unit for operating on both data and addresses. This implies that it is easiest to design a microprocessor that uses exactly the same number of data bits and address bits, not, as you suggest, twice as many bits for address as for data.

The old 8-bit 8080 microprocessor chip would have been a simpler chip if it used only 8 bits for addressing. But that would have addressed only 256 bytes (2 to the 8th power). Instead, the 8080 sticks 2 bytes together to form an address. If you take a closer look at the 8080 instruction set, you'll find that the chip does not do any

arithmetic manipulation on the address when accessing data in memory. The address has to be in registers BC, DE, HL, or immediately following the instruction. The 8080 has minimal 16-bit arithmetic capabilities. Zilog engineers were able to build upon Z-80 architecture by adding some 16-bit operations. They even added an indexed address, where the address is the sum of the 16-bit IX or IY registers and an 8-bit number.

Now we come to the Intel 8086 and 8088 chips, and things get more complex. Both these microprocessors are internally 16-bit chips. (Externally, the 8088 used in the PC and XT accesses memory in bytes.) All the instructions use either 8 bits or 16 bits, although there is some use of 32 bits (two registers together) for multiply and divide.

The easiest addressing space for these microprocessors would have been 64K (2^{16}). But following the 8080, that would have been disappointing. So instead, these chips calculate a physical address by adding a 16-bit offset register to a 16-bit segment register that has been shifted left 4 bits. The result is a 20-bit address for accessing 1 megabyte. That's what the PC and XT can do. But the chip is really only working with 16 bits for both data and the address. Aside from generating the 20-bit address, it does not really do any 20-bit calculations.

With the 80286, things get even more complex. In real mode, the 80286 works the same as the 8086 and 8088. In protected mode, however, the segment registers are "selectors" for accessing a 24-bit "base address" from memory. The chip then adds this to the 16-bit offset address. This gives a 24-bit address that can access 16 megabytes of memory. This is the amount of physical memory the 80286 will address with the new version of DOS expected from Microsoft later this year. (The new version of DOS is also expected to support virtual memory, but that's a whole other topic.)

The 80386 is a full-fledged 32-bit microprocessor. It stores data in 32-bit registers, and it can do full 32-bit arithmetic. It uses a 32-bit address that can directly access 4 gigabytes (4 billion bytes) of memory. Like the 80286 in protected mode, the 80386 uses a selector to reference a base

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■ PC TUTOR

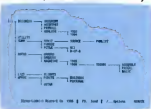
address that it adds to an offset address, but the base address and offset address are both 32 bits. The only time the 80386 uses 64 bits is when doing double-word multiplies and divides.

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USING TWO DISPLAYS

I have both a monochrome and a color display attached to my PC. The system boots on the monochrome display. However, I have not been able to get both monitors to display text information simultaneously. Moreover, many of my graphics programs will not work when the monochrome board is installed. Some graphics programs that boot from their own diskettes work, but most others do not. How can I use the color display without removing the monochrome board? Is there an external switch or a resident program I can use?

William A. Parker
Manchester, New Hampshire

Two video adapter boards—a Color/ Graphics (or Enhanced Graphics) and an IBM Monochrome (or compatible) Adapter—can coexist quite well on PCs. If the color board is a Color/ Graphics Adapter, the system board switches must be set for a monochrome, on which the system will boot. If the color board is an EGA, you can set the EGA switches so the system boots on either the color or monochrome.

You cannot use the two displays simultaneously to display the same program output, but you can very easily switch between the displays. It's not an external switch. It's not a patch to COMMAND.COM. It's not something you have to do in DEBUG. It's not a resident program. It's a fully-documented DOS command called MODE. To switch to the color from the monochrome, execute

MODE COLOR

Now you should be able to run all your graphics programs without problems. To switch back to the monochrome, execute

MODE MONO

Some programs—most notably Lotus's 1-2-3—can be installed to use both displays: 1-2-3 will display worksheets on the monochrome and graphs on the color monitor. Many programmers use a second display for debugging. Microsoft's recent CodeView debugger, for instance, lets a program run on the current display and shows the CodeView screen on the other display.

However, most programs that use graphics require that the program be exe-

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PRODUCTIVITY

■ PC TUTOR

cuted when the color display is active. Programs generally determine whether they are running on a monochrome or color display by making a BIOS Equipment Check call or by getting the current video mode. Neither of these methods gives any hint that another display is attached to the system, so the programs have to assume that your current display is your only display. If the current display is a monochrome, they won't run.

If regular programs cannot determine that another display is present in the system, how can MODE do it? Very awkwardly. MODE checks for a second video board by actually accessing the physical display memory. If it finds something there, it then changes the Equipment Check byte (something you wouldn't want an applications program to do) to fool the BIOS when MODE calls it to switch to the video mode of the other display.

If you generally use the monochrome display for most PC work, you can set up some batch files for running graphics software. For instance, if you had a graphics program called GRAFPROG.EXE, you could make a batch file called GP.BAT:

```
MODE C080
GRAFPROG
MODE MONO
```

This switches to the color display, runs GRAFPROG, and then switches back to the monochrome.

You might also be interested in John Dickinson's DOORS program ("Try a Door, Not a Window," PC Magazine, Volume 4 Number 3). This is a resident program that allows you to switch between monitors from the keyboard using the Alt and Right Shift keys. Many programs won't work right if you try to switch displays while they are running, but DOORS works just fine at the DOS command level. DOORS is also very handy for taking "snapshots" of your screen on the second monitor by triggering the Alt and Right Shift keys twice in succession.

ASK THE PC TUTOR

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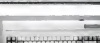
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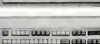
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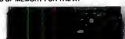
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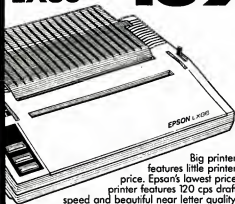
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- h ☐ Hard Disk/Tape Back-up
i ☐ Add-in Boards
j ☐ LANs
k ☐ Micro-Frame Links

Software

- l ☐ Communications
m ☐ Accounting
n ☐ Spreadsheets
o ☐ Financial Planners

- p ☐ Project Managers
q ☐ Word Processors
r ☐ Database Managers
s ☐ Graphics

- 2) Your primary job function is (check)

- s ☐ Administrative/General Management
t ☐ MIS/D/Communications Systems, Programming
u ☐ Engineering/R&D
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- 3) Next step after information is received:

- x ☐ Purchase Order
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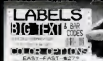
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